The Welding Engineer

Edited by L. B. Mackenzie

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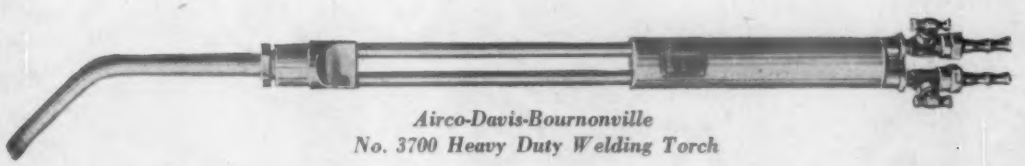
AIRCO DAVIS APPARATUS

ANYTHING AND EVERYTHING
FOR OXYACETYLENE WELDING AND CUTTING



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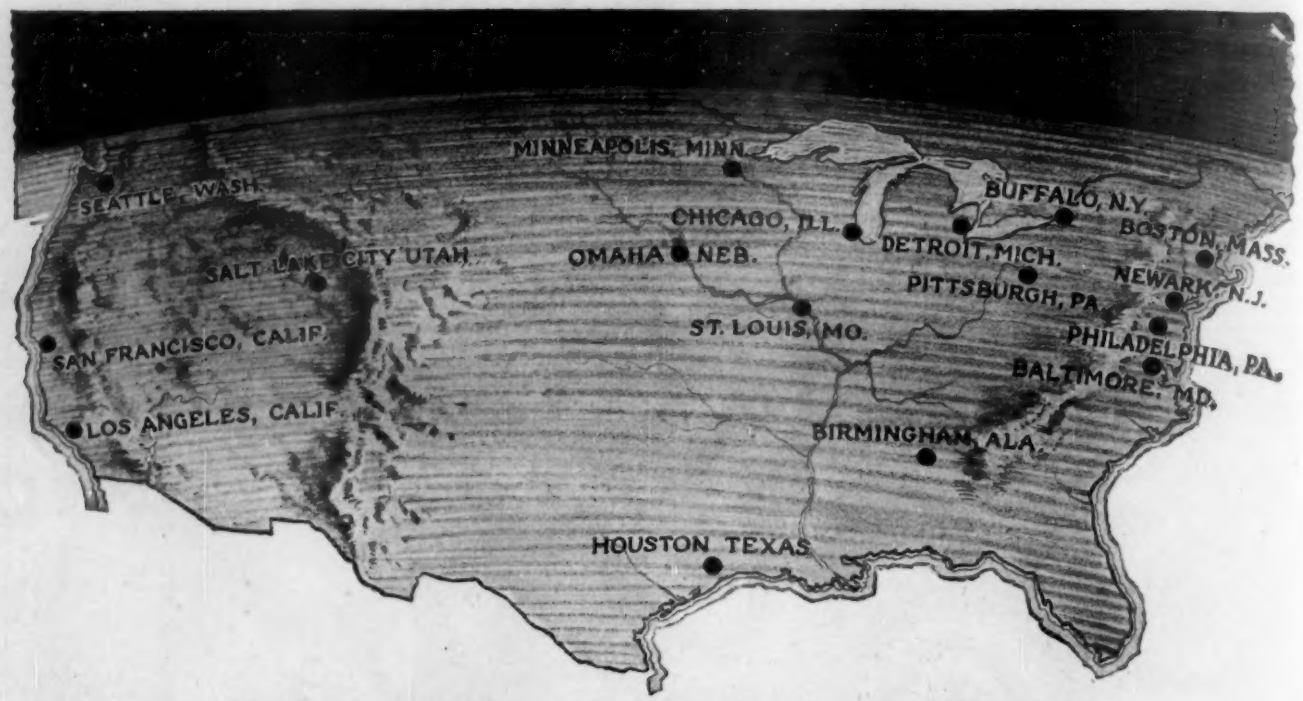

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Buyers' Index

Readers of The Welding Engineer will find this index to contain the most accurate information obtainable relating to welding apparatus and supplies. The advertising section includes the principal manufacturers of the United States.

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Cleveland.....631 Hanna Bldg. Annex
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Portland.....15th and Hoyt Sts.

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Harrisburg.....25 S. Tenth St.
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Scranton.....Penn Ave. and Vine St.
Shamokin.....Fifth and Walnut Sts.
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There is no worth while feature of modern welding science but what you will find in Smith Acetylene Generating and Welding Equipment. Many patented Smith features are unobtainable elsewhere.

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Exclusive Manufacturers of Welding and Cutting Equipment

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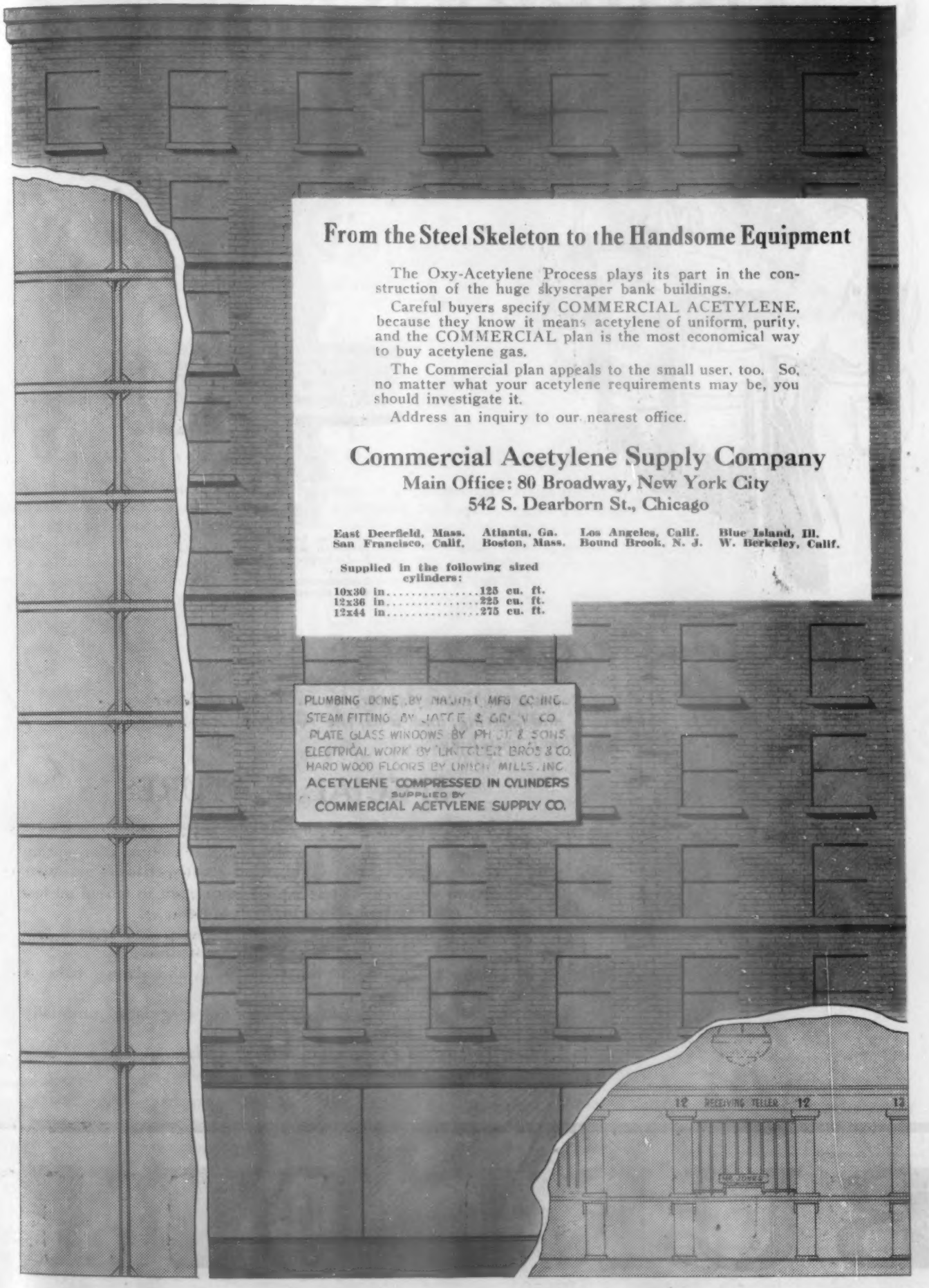
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Supplied in the following sized cylinders:
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PLUMBING DONE BY
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ACETYLENE COMPRESSED IN CYLINDERS
SUPPLIED BY
COMMERCIAL ACETYLENE SUPPLY CO.

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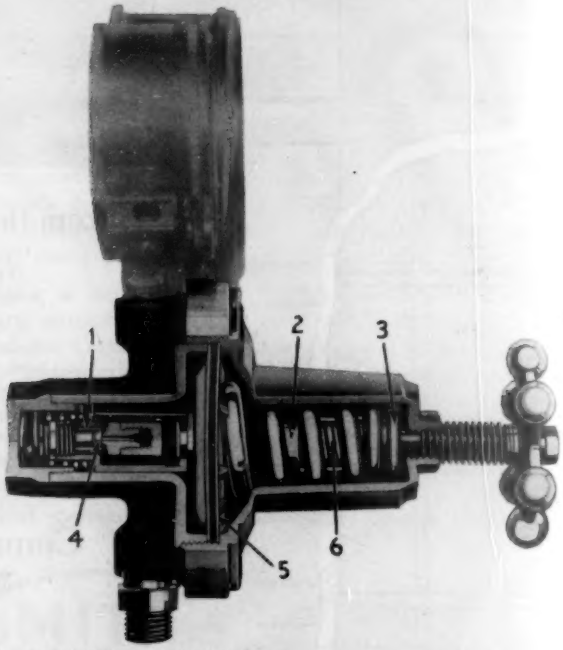


1—Valve Seat Guide.
2—Small Spring Container.
3—Compression Spring.
4—Seat.
5—Diaphragm.
6—Expansion Spring.

Hy Grade says:

The BURCO Regulator is a real money saver, because one regulator serves for both welding and cutting, and it is the first regulator I've seen that will work without watching.

SPECIAL FEATURES

The BURCO Regulator is a high-and-low-pressure regulator.

Expansion spring for low pressures, and compression spring for high pressures. This combination greatly reduces variation.

Maximum variation of one pound from open to closed on low pressures, and two pounds on high pressures.

The diaphragm is made of specially tested and treated diaphragm rubber cloth, and is extremely sensitive.

Regulator seat guide prevents wabbling, and always makes a positive gas tight seat.

The sturdy bronze body makes this regulator unusually rugged.

All springs are of the highest quality material, and will keep their life and sensitiveness indefinitely.

BURDETT

to Back up Your Torches

What will a BURCO Regulator do?

It will make it unnecessary to purchase two oxygen regulators.

The **BURCO** Regulator will perform equally well on both welding and cutting.

The apparatus cost is reduced by using one regulator instead of two.

The repair cost is reduced because the valve seat is self-aligning, and always gives a positive gas tight connection.

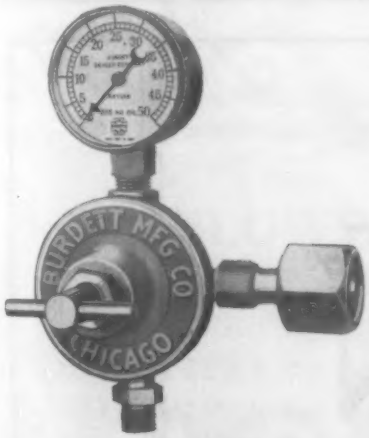
The **BURCO** Regulators will last indefinitely because the springs are of the highest quality material and retain their sensitiveness.

Operating time is reduced because this regulator will work without watching.

Operating time is reduced further because no time is lost in changing oxygen regulators when going from welding to cutting.

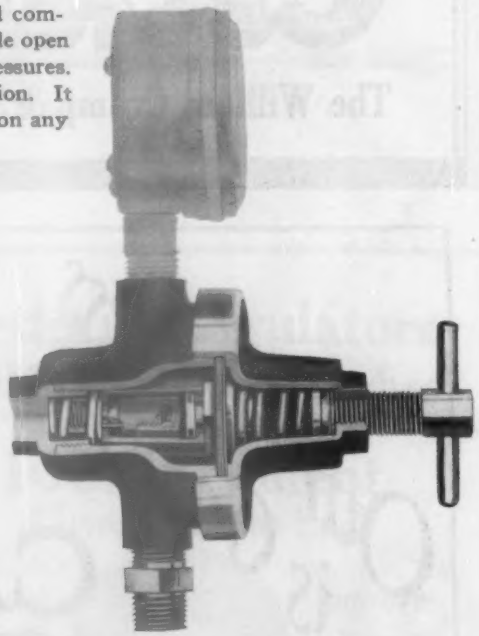
This is a Real Test Which BURCO Regulators Will Stand:

The diaphragm of the BURCO regulator is made of a special double fabric and composition rubber which renders the regulator very sensitive. Its fluctuation from wide open to closed is from 10 to 13 oz. on low pressures and from 2 to 2½ lbs. on high pressures. This is something never accomplished before in the history of regulator construction. It marks a distinctive advance in pressure regulators. Make this test of fluctuation on any other regulator and see for yourself how it compares with the BURCO.



BURCO
SINGLE GAUGE REGULATOR
FOR LIGHT WORK

This is a high grade regulator in every respect, constructed for use in carbon burning, lead burning and light sheet metal welding. A complete regulator with one gauge is shown at the left, and a cutaway view showing **BURCO** construction at the right.



BURCO Regulators both single gauge and double gauge can be supplied for use with oxygen, hydrogen, acetylene and carbo-hydrogen. In fact, BURCO Regulators can be supplied to work with any compressible gas. Submit your regulator requirements to us, and we will promptly furnish details and prices.

Correspondence is invited from distributors who can give the BURCO Line suitable representation in territory which is, as yet, unassigned.

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Cramp's Welding Rods

We also furnish Welding Rods of Cast Iron, Copper Covered Iron and American Iron for welding steel, Vanadium Steel, Nickel Steel, Cast Aluminum, Drawn Aluminum, Soft Brass and Phosphor Bronze, also Steel Electric Welding Rods both flux covered and uncoated.

Parsons' Manganese Bronze

Rolled Welding Rods—The strongest bronze welding rods made for Oxy-Acetylene Welding and High Fire Brazing of Malleable Iron, Brass and Bronze. The use of Parsons' Manganese Bronze Filler Rods in brazing malleable iron results in the strongest possible weld or braze and insures satisfactory work.

Cramp's Cast Iron Solder

for repairing Scored Cylinders and Water Jackets, etc. Thoroughly tried for several years by our customers and found entirely satisfactory.

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A joint properly made with this solder is stronger than the original casting and is preferable to a welded joint.

CRAMP

We furnish and will be glad to estimate on all kinds of brass and bronze castings.

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IN THE
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IS TESTIMONY
OF YOUR INTEREST IN
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SEND YOUR REQUEST FOR
APPLICATION BLANK TO

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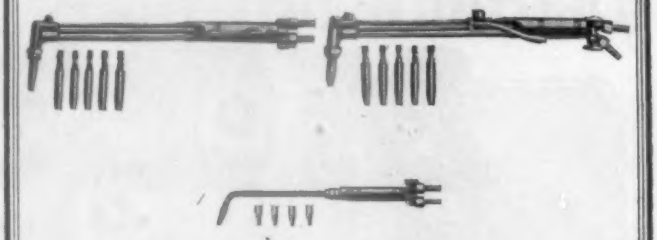

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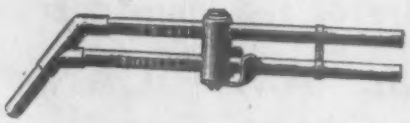

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BLOWPIPES for light brazing.
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BLOWPIPES for lead burning.
BLOWPIPES for heating work to be welded by the oxy-acetylene process.

Let us know your requirements and we will give you the benefit of our many years' experience in blowpipe work.

Our catalog "BX" illustrates and describes them all. Ask for it.

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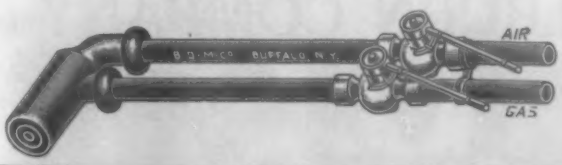
BUFFALO, N. Y., U. S. A.



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Help SELL Your Torches

100% Efficient
Cheapest in the End

Improve Your Torches By Using "Federal" Regulators

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FEDERAL BRASS WORKS
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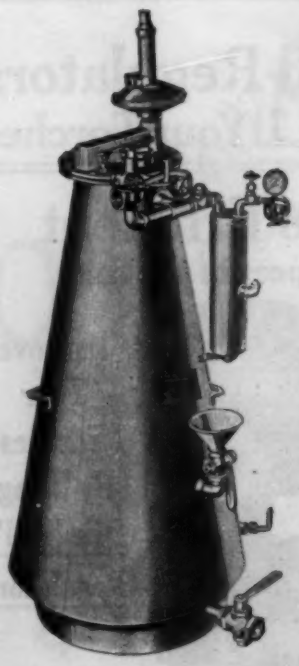
A Real Combination for the Trade—

The MILBURN CUT-WELD COMBINATION TORCH

Cuts and Welds with Equal Efficiency



Standard on leading Railroads and Industrials and

THE NEW 30 lb. "AMERICAN TYPE" GENERATOR

Eliminates High Cost of Cylinder Gas

FEATURES

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- Steel body welded throughout.
- Semi-portable-cone shape 2 foot base.
- Quickly and easily recharged.
- Oversize Sludge outlet.
- All parts quickly get-at-able.
- Efficiency guaranteed.

Other Generators 60 to 500 Pounds Carbide Capacity
Good Territory for Live Agents.

THE ALEXANDER MILBURN COMPANY

1416-1428 West Baltimore St., Baltimore, Md.

They've Been Welding on the Railroad

This is a drawing from an actual photograph showing the broken frame of a locomotive that is being repaired with a Westinghouse arc-welding outfit — not in the shops but on the right-of-way.

Electric Welding

Saves Time — Money — Material

A broken frame stopped this locomotive and threatened a trip to the shops, a disorganized schedule, a long delay for passengers and express matter, and a cost that would have been very serious.

But a Westinghouse salesman happened along!

After that, it was only a matter of a few hours till the train was on its way again; the frame *permanently* and *properly* repaired by a portable welding set which had been operated by the same tractor that drew it out from a nearby town. Just think about that a minute!

What do they do in *your* business? Do they weld, or do they wait? Do you, and your plant people, know of the great advantages that electric welding would bring to you? Perhaps you have no idea of the value of the machines and parts that are scrapped or laid up every year just because arc-welding isn't known, or its practical uses understood.

Westinghouse makes arc-welding apparatus for every purpose including a one-man set that can be *taken to the work*. And every manufacturer ought to know of their possibilities for there are few plants in which they will not quickly pay for themselves. Our nearest office will gladly tell you the interesting facts about them.

WESTINGHOUSE
ELECTRIC & MANUFACTURING COMPANY
Offices in all Principal Cities · Representatives Everywhere

Westinghouse

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A Short Story Prize Contest for Welders

The Welding Engineer wants good welding stories; stories which will be helpful to the other fellow. In order to be sure of getting the best stories which welders can contribute from their experience, we are putting them on a competitive basis, and are offering three prizes for the three best stories submitted each month, as follows:

1st Prize: Class C Membership in American Welding Society.

2nd Prize: Class D Membership in American Welding Society.

3rd Prize: Copy of Welding Encyclopedia bound in Leather, Stamped with Owner's Name.

CONDITIONS

There is no restriction as to the length of this story, or the time in which the work is done. The assignment of prizes will be based on the value of the story as a whole to the readers of The Welding Engineer. Manuscript does not have to be typewritten, and it will not be judged upon its literary merits. If sketches are necessary to illustrate any features of the work, you need not submit finished drawings. Pencil sketches will serve the purpose just as well. One point to be kept in mind is that the story ***should be complete enough to enable another welder to do the same job after reading it.*** There is no restriction regarding the nature of the work described. It may be either production work or repair work. It may be oxy-acetylene welding, electric arc welding or thermit welding. The value of the story may consist entirely of a description of the method of preheating in the case of a repair job, or in the construction of a jig in the case of production work. The purpose of the contest is to bring out practical working instructions which will enable the other fellow to do a particularly difficult piece of work.

In case manuscripts are received which are considered good information for our readers, but which are not quite so good as the stories which are winners in the prize contest, they may be printed in The Welding Engineer, in which case the story will be paid for at our regular rates.

Mail your best welding story to

THE WELDING ENGINEER

608 South Dearborn Street CHICAGO, ILLINOIS

NOTICE: Awards of stories received in March will be published in the April 1923, issue of The Welding Engineer.

"Standard Carbide Sets a Standard"

Says Smiling Dave O'Kay

There's a certain amount of inertia in every organization. There comes a time in the career of every enterprise when it reaches the point that it believes is its height. This is the danger mark because when progression stops decline begins.

Our outfit was at this point when I discovered STANDARD CARBIDE. We thought that we were just about the best in our line and let it go at that. I noticed this and realized that if something was not done our heady opinion of ourselves would be our own undoing.

I looked into the matter of Carbides, tried them all. What I was after was a carbide that was as cheap as any and at the same time free from the usual foreign matter that causes the flame to flicker and die at critical moments, slowing production and increasing operating costs.

Then I discovered STANDARD CARBIDE. It had everything in its favor. I found that its claim, "Burns Brighter—Lasts Longer" was founded on the fact that STANDARD had the attributes for which I was looking. Furthermore, it was packed in big blue steel moisture-proof drums that could be bought at any time and stored indefinitely without danger of deterioration.

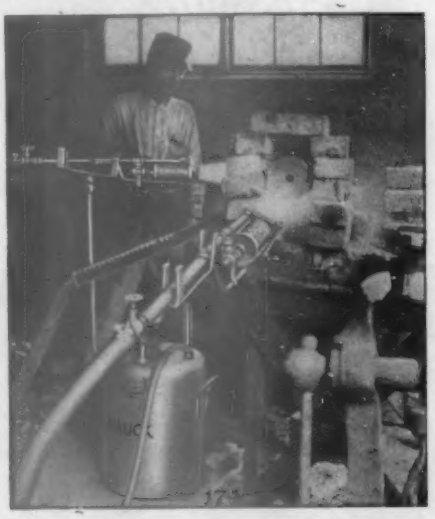
I do not hesitate to recommend STANDARD CARBIDE to anyone anxious to do a better job of welding and cutting, faster and cheaper than he thought possible.

STANDARD CARBIDE has raised our standard of work considerable.

Smiling Dave O'Kay
(EXPERT CUTTER AND WELDER)

Standard Carbide Sales Co., Inc.
Main Office :: 15 West 37th St., New York

WELDING "TIPS" No. 1



"Would not be without it"

Why bother with costly and doubtful preheating methods?

Do it better, cheaper and faster with a Hauck **KEROSENE** Preheater.

Write for Bulletin 127

HAUCK MANUFACTURING CO.
Established 1900
122 Tenth St. Brooklyn, N. Y.

Wanamaker Coated Electrodes
FOR
ARC WELDING

COATED WANAMAKER ELECTRODES

Reduce your labor costs.
Reduce your current costs.
Reduce your electrode material costs.

Increase your production.
Increase the operators' efficiency.
Increase the quality of your welds.

Write for details.

The new Tecor Specialties Bulletin describes the WANAMAKER COATED ELECTRODES, also a complete line of welding accessories.

Write for it today.

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Is made from best grade of coke and lime. Scientifically treated in an electric furnace so as to produce carbide of excellent quality and large gas yield.

For ACETYLENE GENERATORS

Sizes

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2x½
1¼x⅜
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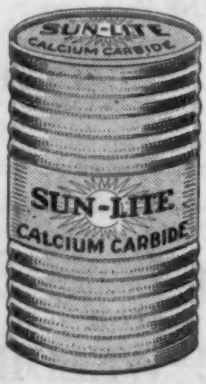

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Oxy-Acetylene Equipment and Supplies

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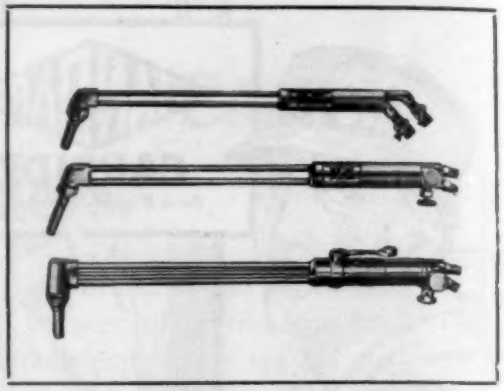

K-G

Cutting Welding

TORCHES

Any Length Desired for Any Gas Desired

K-G Welding and Cutting Co., Inc.

Home Office and Factory

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Conforming to Spec. E1B and G1A of The American Welding Society

ROEBLING ELECTRODES

Absolutely uniform in quality

Roebling Wire Electrodes are supplied in the following standard sizes: ¼-in.; 5/32-in.; 11/64-in.; ⅛-in.; 9/64-in.; 7/32-in.; 5/16-in., having a standard length of 14-in., in bundles 50 lbs. each, and are always available for quick shipment. Sizes other than the above and as large in diameter as ½-in., having any length required, either straightened or in coils can be furnished on order. Roebling Electrodes give maximum penetration and maximum strength of welds.

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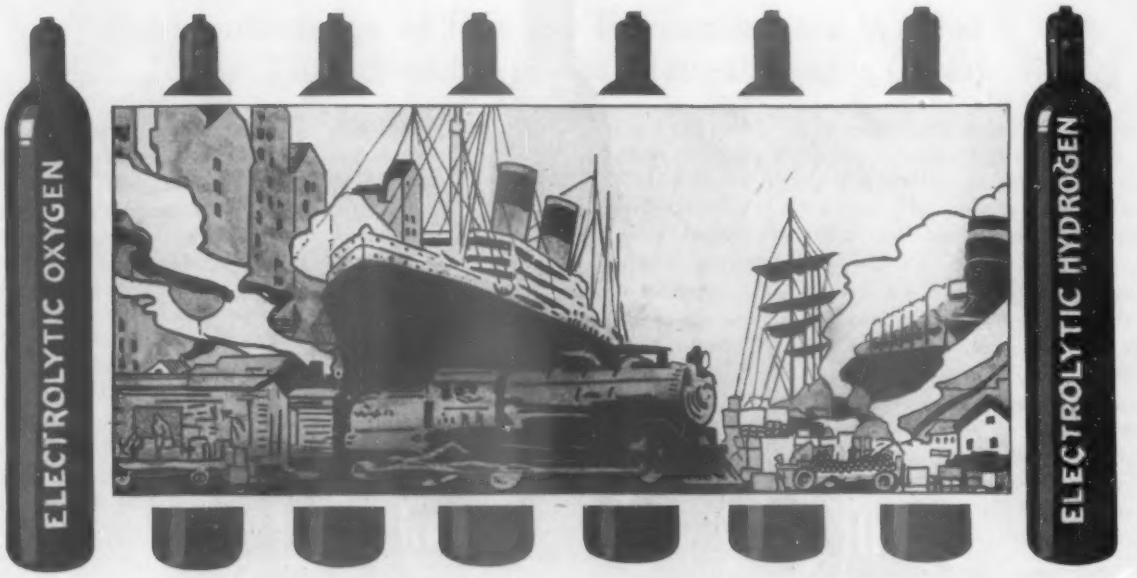
JOHN A. ROEBLING'S SONS CO.

TRENTON, N. J.



A Universal Service

THE last quarter century has seen the development of the oxy-acetylene welding process from a somewhat problematical method to a scientific one.

Science and invention, inspired by the demand for a thoroughly understood welding process, have given the industrial world the oxy-acetylene process as a universal method adaptable to any kind of work, under any condition.

The members of the GAS PRODUCTS ASSOCIATION have been instrumental in developing the science of gas welding. Their products are universally used in all industries of the country. If you have a welding problem, refer it to some one of the companies listed below for expert advice.

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California Compressed Gas Co., Los Angeles
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COLORADO
Colorado Compressed Gas Co., Denver

ILLINOIS
Acme Oxygen Co., Chicago
Burdett Oxygen & Hydrogen Co., Chicago
Electrox Co., Peoria
National Oxygen Co., Chicago
Swift & Co., Chicago

INDIANA
Indiana Oxygen Co., Indianapolis
Logansport Oxygen Co., Logansport

IOWA
Bettendorf Oxygen Hydrogen Co., Bettendorf

KENTUCKY
Kentucky Oxygen & Hydrogen Co., Louisville

LOUISIANA
Louisiana Oxygen Co., Inc., New Orleans

MANITOBA
Auto-Lite Gas Co., Ltd., Winnipeg

MICHIGAN
Burdett Oxygen Co., of Detroit, Detroit
Michigan Ox-Hydric Co., Muskegon
National Oxygen & Machinery Co., Detroit

MINNESOTA
Commercial Gas Co., Minneapolis

MISSOURI
Kansas City Oxygen Gas Co., Kansas City (two plants in Kansas City)
St. Louis Oxygen Co., St. Louis

MONTANA
Mountaineer Welders' Supply Co., Butte

NEBRASKA
The Balbach Co., Omaha

NEW YORK
American Oxygen Machinery Corp., New York

OHIO
Clarke Chemical Co., Wickliffe
Ohio Electrolytic Oxygen Co., Cincinnati

OKLAHOMA
Burdett Oxygen Co., of Oklahoma, Oklahoma City
Tulsa Oxy-Hydro Co., Tulsa

OREGON
Portland Oxygen & Hydrogen Co., Portland

PENNSYLVANIA
Burdett Oxygen Co., Philadelphia (plants at Chester and Norristown)
Burdett Oxygen & Hydrogen Co., Pittsburgh
National Oxygen Co., Erie

TENNESSEE
Burdett Oxygen Co., Chattanooga
Memphis Oxygen Co., Memphis

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Burdett Oxygen Co., of Texas, Fort Worth
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Linde Service goes beyond the mere supplying of its products. It includes a carefully planned method of bringing engineering advice and assistance into close touch in the field with the individual user's problems and needs.

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Carbide and Carbon Building, 30 East 42d St., New York City

31 plants—58 warehouses

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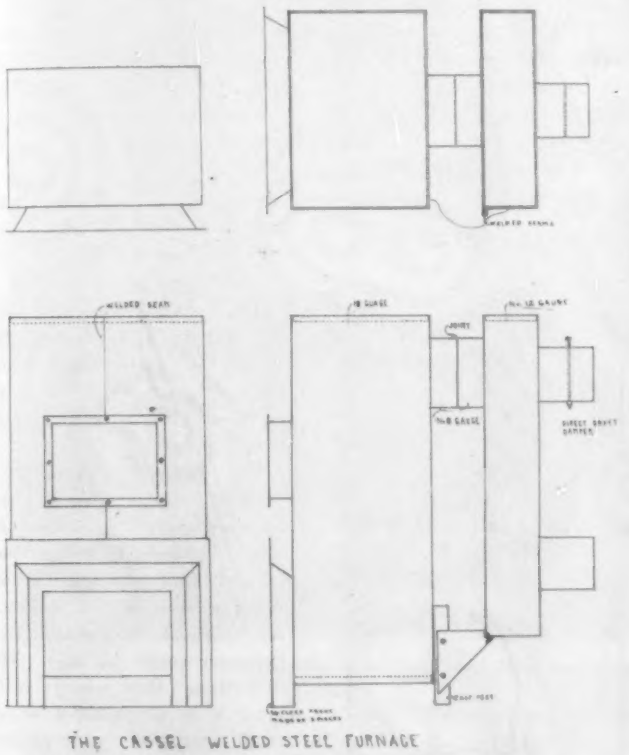
LINDE OXYGEN

WELDED STEEL FURNACE

Manufacturer of Hot Air Furnaces Uses Welded Joints Throughout—Keeps Heat Passages Clean

YEARS ago when our forefathers gathered 'round their hearths of an evening, they probably thought they possessed as perfect heating systems as it was possible to devise. They could conceive of nothing better than the warm glow which came from the crackling logs and flooded the room with its comfort and cheer. The thought that some day their own descendants would heat their homes by a central plant, that each room would be warm and that there would be a minimum of inconvenience was beyond their comprehension. Inventive genius, however, not satisfied with the hearth, tackled the heating problem and produced the systems in use today.

The universal popularity of a central heating plant for the home suggested to Joseph Cassell, of Philadelphia, the possibility of making an all welded furnace on a production basis. He made a careful study of furnaces and developed the Cassel Welded Steel Furnace. It is based on a very careful and detailed study of the whole question of home heating and in the warmth it produces, the healthful atmosphere it provides, and in its economy of installation and operation it comes as close to perfection as any man-made device can.



Construction Details of Welded Furnace.

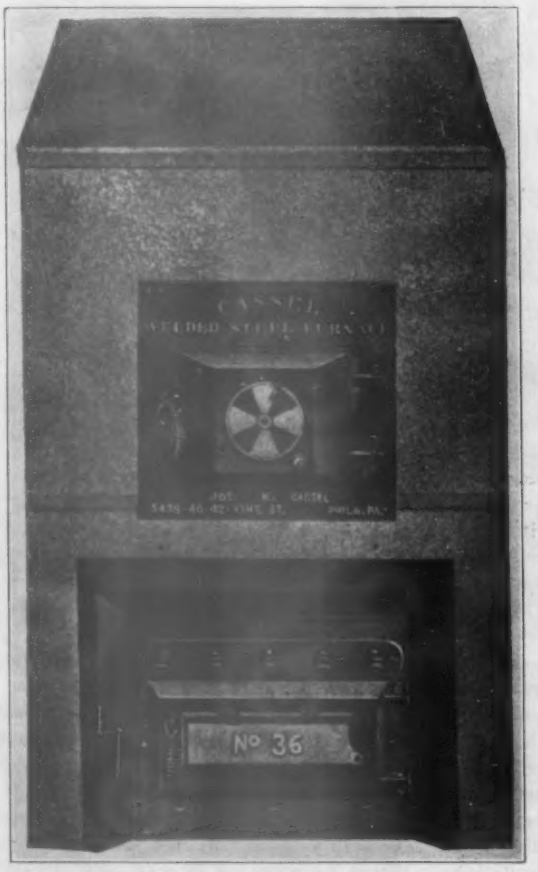
The Cassel Welded Steel Furnace might be called an air conditioner, providing as it does not only ample warmth, but constituting its own ventilating system and assuring an adequate supply of moisture in the air. The vapor pans provide the proper moisture and keep the atmosphere in the home healthful.

The first improvement found in the Cassel Furnace is in the acetylene welding. In some warm air heaters whose joints are not tight there is the possibility that dust from the ash box or coal gas from the fire might work their way into the heat passages. In the Cassel Welded Steel Furnace this is impossible. Every joint in the entire heater is welded, making it absolutely dust and gas proof. In no way can anything but pure, wholesome air enter the pipes which supply warmth to the house.

The furnace is made of 8, 10 and 12 gauge steel sheet, oxy-acetylene welded at all joints. The front is made of three pieces of steel, formed, welded at the miters, and the whole welded directly to the body of the furnace.

The furnace body is made of three sheets, the large one is turned at the corners, and butt welded at the seam in front. The top and bottom sheets are flanged, and then welded in place. The construction of the radiator is similar to that of the body.

The firebrick lined combustion chambers makes combustion very intense, and the fuel is very thoroughly burned. Heat is transmitted faster through steel sheet than through cast iron. This type of construction with the welded joints makes an absolutely gas and dust proof furnace, one that will last indefinitely.



The Complete Furnace.

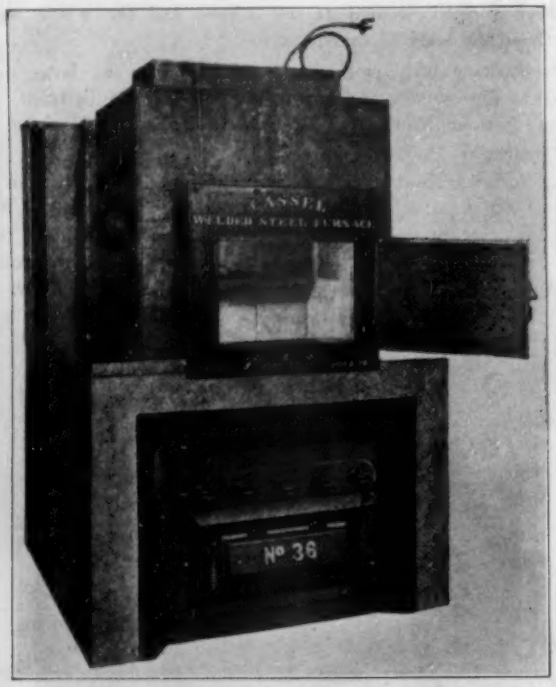
The next distinctive feature is the provision made for supplying an adequate amount of moisture to the air. In the ordinary warm air system the vapor pan is situated near the bottom of the heater where it can function only imperfectly and must constantly be supplied with water. In the Cassel Welded Steel Furnace both of these objections are overcome. The vapor pan is placed on top of the furnace, the hottest place in the heater, where the warm air on its way through the house passes over it, gathers in the moisture, and carries it with it. The amount of water needed in the vapor pan is automatically supplied by a connection with a water pipe. It requires no attention whatever.

Another achievement of the Cassel Furnace is the result of

its unique appearance. The majority of heaters are circular in form. The Cassel Furnace is square. This provides for a greater area of radiation. It means more heat from less coal.

The construction of the grates follows along the same line of efficiency and economy. Each bar works independently of the others and may be completely revolved. This permits of the fire being raked at only such parts of the furnace as require raking.

In common with warm air heaters, the Cassel Furnace furnishes a quick warm temperature. There is no necessity of



The Inside of the Heater.

building a high fire as is the case with steam and hot water. Just a little blaze in this heater and the cheerful warmth is spread without delay through the entire house.

The manufacturer emphasizes the benefits of welded joints, and it is interesting to note that the process which is proving easier to use in his production is also proving a source of greater satisfaction to his customers.

STUDY THE WELDING ART

Electric arc welding has already been the means of saving the railroads many thousands of dollars both in the repair of broken equipment and in the reclamation of worn parts which in the past, have been thrown on to the scrap pile. There are certain to be many more applications for welding as the practice comes into more general use, but it will prove a very great mistake if arc welding is applied indiscriminately. Welding is unquestionably a great money saver and yet it has its limitations. When an attempt is made to exceed these limitations by welding parts or materials which from the nature of their functions cannot give satisfactory service, the art is not only retarded but is given a decided set-back.

It should be the aim of every welding supervisor to study carefully what *is* possible of accomplishment and what cannot be undertaken with the certainty of success. The different jobs that have been welded total up to an astounding figure and cover an exceedingly wide scope. A welding supervisor must have a wealth of experience to be able to tell in advance what can be expected of any particular job that comes to his attention for the first time. If his experience has taught him that a certain weld will not stand up in the strenuous work which the part must perform, it is a great mistake to make such a weld, for not only does the work fail to give satisfaction and in some instances perhaps prove dangerous, but it invariably puts the welding art in bad repute and hampers its legitimate progress.

The attempt to weld something which should not be welded, however, is not the only way in which reflections may be cast upon the art. It is also of greatest importance to know what kind of welding materials and what method of procedure to use.

Another thing which plays a great part in successful arc welding is the right preparation of the work. Careless preparation and dirty material can only result in poorly executed work.

These and other important points are clearly brought out in an article on this subject which appears on page 283 of this issue. Study the results of others. Be warned by their failures and strive to emulate their successes. There is no royal road to electric arc welding and he who leads in the art will be he who through diligent search and study has become a master of the numerous factors that enter into the accomplishments of a perfect weld.—*Railway Electrical Engineer.*

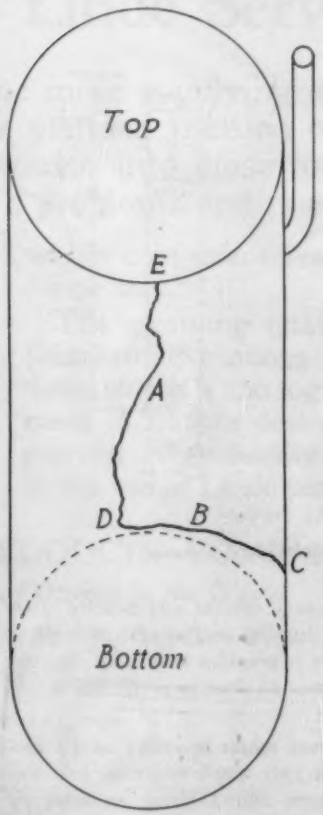
CRACKED HEATER TANK MADE FIT FOR SERVICE

By "Andy."

This job was on the largest farm tank heater I have ever seen; made of cast iron 38 inches high, 20 inches wide with ⅛-inch sides.

The farmer wanted it at once and wanted to take it home. The job came in the shop about noon and of course had to be done by evening.

The letters in the diagram indicate the crack which extended the entire length of the tank and about 12 inches between D and C.



The welding procedure was as follows: I ground the break back about ½-inch on each side of the break then V-ed it out to the bottom of the crack.

The idea of grinding back from the break was to clean it thoroughly. I knew the break between E and D had to be brazed on account of its being a hurry up job. I could not preheat it because the customer could not wait. The first thing, then was to weld from C to D; insert a wedge at A to spread the break and when welded take out the wedge at A and let cool.

After cooling, insert the wedge at E to spread the break about ⅛-inch. I started to braze at D running the bronze through and working fast until completed. Then I covered it. When the job was cooled we tested it out in our radiator test tank and the work was O. K. No checks showed up whatever.

TORCHWELD ISSUES PIECE PARTS CATALOGUE

A new piece parts catalogue has just been published by the Torchweld Equipment Co. of Chicago. The parts shown in the catalogue are for minor repairs which ordinarily can be successfully made by users of apparatus. The list includes the torches, tips and other parts for the Torchweld Welding and Cutting Torches and Gas Pressure Regulators.

REPAIRING PIPE UNDER PRESSURE*

36-Inch Steel Pipe Line Repaired by Electric Welding While Under Pressure of Ninety Pounds

By John N. Foulks†

THE following account of repair work accomplished by the bureau of water of Newark is doubly interesting as illustrating the method adopted by Mr. Foulks in performing the electric welding of the steel pipe and in the fact that the work was done while the pipe was under 90 pounds water pressure. As Mr. Foulks has had considerable experience along these lines he speaks with some authority on the subject.

The city of Newark in 1891 laid 26 miles of 36-inch and 48-inch riveted steel pipe, and in 1904 laid a second and third line 28 miles in all, of 42-inch, 48-inch and 60-inch riveted steel pipe. Up to the present time the only difficulties encountered have been where the two lines extend through a peat swamp; at this point electrolytic action has taken place, due to stray currents from trolleys, or to local action in the soil. The pipe has become pitted badly in places, as shown in Fig. 1, and from time to time these pits have given way, causing small leaks, which have been repaired temporarily as follows: by plugging the holes with pine plugs, which were braced with concrete when the holes occurred on the side or bottom of the pipe; by capping the plug with a lead cover, which was held in place by braces extending to the sides or bottom of the trench; or by pulling steel bands in place with bolts and running lead between the pipe and the bands.

Fig. 1. Showing Pits in 36-Inch Steel Pipe, One Leak Having Developed. Taken Just Before Repairs Were Begun.

Electric Welding Gave Good Results

While the methods used have answered the purpose up to the present time, they are makeshift, and it has been necessary to look for a better and more permanent repair or replace certain sections of the line. As I have had considerable experience in using electric welding for making other repairs that were somewhat similar, I decided to give it a trial on this work, and produced excellent results on the 36-inch line laid from Belleville Reservoir to the 60-inch feeder on Bloomfield Avenue, running through the swampy section mentioned above.

Repairs Made With Pipes Under Pressure

At this point the thickness of the pipe, which carries a pressure of 90 pounds, is 5/16 of an inch. The pipe sprung a leak which showed up on the surface and it was uncovered in two sections for a distance of approximately 10 and 15 feet, respectively, and repairs were made without shutting off the water or reducing the pressure. After thoroughly cleaning the pipe it was found to be pitted badly and a hole approximately ⅜ of an inch in diameter was plugged with a pine plug. The plug was then cut off with a hacksaw flush with the surface of the pipe and covered with a metal cap, held in place by tacking it on the slides by means of the electric arc.

The cap used consisted of metal of approximately No. 11 gauge, obtained from punchings, and was slightly concave. Metal was then welded over this cap, extending far enough over the edges to get a firm hold on the pipe. All the pits were filled and reinforced by welding and a triangular patch of about 9 inches on each side was welded over a number of pits which occurred in one spot. The pipe was then recoated, making a permanent job. (See Fig. 2.)

Two Sections of Line Welded

Two sections of the line were welded in this manner and the following costs were kept:

2 men, 8 hours	$12.50
1 laborer, 8 hours	4.56
Materials, including steel, gas, oil, etc	2.10
Total	$19.16

This makes an average cost of .77 cent per lineal foot for repairing and reclaiming the pipe in this section. These costs do not take into account the cost or depreciation of the machine—

Reproduced from Fire and Water Engineering by courtesy of the publishers.

†*Chief Engineer, Bureau of Water, Newark, N. J.*

a gasoline driven arc welding set, mounted on a Ford chassis, consisting of a 4-cylinder, 4-cycle, vertical type engine, direct connected by flexible coupling to a 200-ampere constant energy

Fig. 2. Upper, Repairing Steel Pipe Showing Wooden Plug in Place Slightly to Right of Patch in Pipe. Lower, Pipe After Repairs by Electric Welding Have Been Completed.

type self-excited arc welding generator, with inherent regulations, complete with panel for current regulated steps from 75 to 200 amperes; nor do the costs include excavating and backfilling, which would have to be made in case of any repair or replacement. The condition of the pipe on the sections welded was very bad and the costs for doing the work were maximum as the men were not thoroughly familiar with this class of repair. If cast iron had been used under the same conditions these lines undoubtedly would have deteriorated under the electrolytic action and it would have been impossible to repair them by electric welding.

Life of Steel Pipe Underestimated

It was estimated when the Newark lines were laid in 1891 that the probable life would be approximately 30 years. When the 60-inch line was laid bids were received for both steel and cast iron, and it was found that the difference in cost between the steel and cast iron was so great that the steel line could be renewed in 13 or 14 years for the difference. The records up to the present time in reference to the life of steel lines are not as numerous as they are for the cast iron lines, but there is ample proof to show that the life of steel lines is very much underestimated in a great many cases, as lines have been in service for a period of 40 or 50 years that are still in excellent condition.

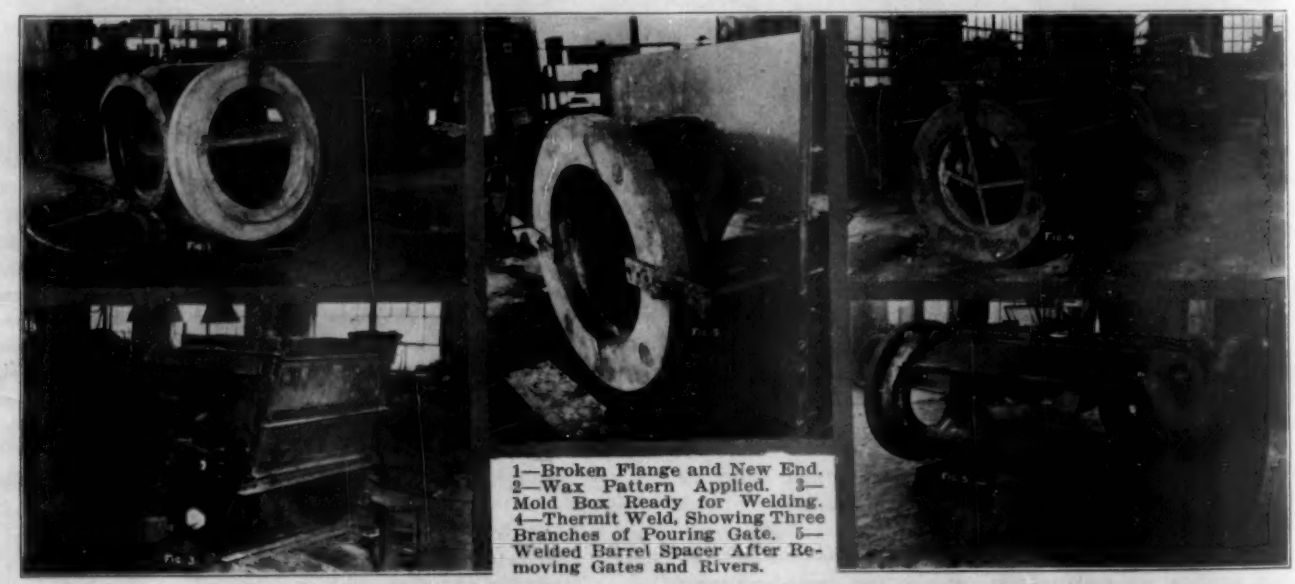
REPLACING THE FLANGED END OF A BARREL SPACER

The flanged end of a 34-in. diameter cast iron barrel spacer for the cross head slide of a 800 h. p. reciprocating engine operated by the Giant Portland Cement Company, Egypt, Pa., broke off so close to the flanged face that it was found impractical to weld it, because in so doing the bolt holes of the flange would have been thrown slightly out of the very exact alignment required, also because the length of the barrel spacer would thereby have been made incorrect.

This difficulty was overcome by discarding the old flange, casting a new flange having an inside projection of 3 in. as shown in Figure 1 and cutting off an equivalent 3 in. from the end of the barrel spacer, then placing and bolting the new flange in alignment as shown in Figure 2. This procedure permitted a weld to be made which did not overlap the flange. The new flange was made sufficiently thick to allow for machining off its outside face ends to the cylinder.

The collar of the cast iron Thermit weld owing to its hardness had to be removed by means of a portable grinder. As the finished surface at these ends was, therefore, naturally less true than in the case of machine tooling, the surface was ground slightly below the present surface of the slides in order that there would be no high spots to interfere with the action of the cross head. The new flange casting was made of sufficient thickness to allow for machining.

In pouring this circular weld, the pouring gate was set close to the weld and the liquid steel allowed to distribute itself more uniformly by means of three branch gates reaching to different parts of the weld as shown in Figure 4, thus avoiding premature chilling of the metal.



1—Broken Flange and New End. 2—Wax Pattern Applied. 3—Mold Box Ready for Welding. 4—Thermit Weld, Showing Three Branches of Pouring Gate. 5—Welded Barrel Spacer After Removing Gates and Rivers.

Flange Welded to Barrel Spacer of Cross Head Slide for Reciprocating Engine.

A DEFENSE OF THE WELDING SCHOOL

Many Welding Schools Are Necessary—Many of the Existing Ones Turn Out Good Welders—Types of Schools

By R. K. Randall

IT has always seemed strange to the writer that while most men go to schools to learn bookkeeping arithmetic, plumbing, machine shop practice, auto mechanics, woodworking, tinsmithing, drafting, show card writing, and, in fact, most every recognized trade, the average welder or employer of welders is unwilling to concede the fact that welding may be successfully taught at a school. This prejudice against graduates of a welding school does much indirectly to injure the game.

The reason this prejudice exists is probably due to the fact that most men, successful and otherwise, in the welding industry, have had to fight and pull their own way up the ladder with little or no help from outside sources, and are reluctant to admit that knowledge which they have had to work hard for may be imparted to men in a short time. It should be remembered, however, that we had to creep before we could walk, and the same thing applies to the graduate of any school, welding or otherwise. A man leaving a technical school must necessarily be shop broke; he must obtain his first job and start to work amid surroundings which are unfamiliar to him, and with a certain amount of shop-shyness which comes from inexperience. However, in other lines of industry the graduate of a school is taken into the shop with full knowledge of his limited ability, and gradually "given a show." It does seem as though a welding school graduate was entitled to the same consideration.

By "welding school" I do not mean a type of school that is run merely for profit, but the type of school that is found scattered in various cities of this country, where welding is taught along standardized lines and where personal gain in no way enters into the subject. Some may perhaps say there is no standardized way to teach welding, but it seems to the writer that from among the mass of welding literature that exists today enough necessary recognized facts may be grouped so as to form the outline of a comprehensive, intensive and intelligent course.

To begin with, the school itself must be equipped in a thorough manner. It should include at least one each of the various standard makes of torches with sets of tips for same. Material given to students for practice work should consist of various shapes, thicknesses and sorts of metal. Scrap steel especially should be abundant as it is the writer's contention that steel offers more difficulties to successful welding than any other metal. A great deal of criticism has been raised about the method of giving a student an acetelyne torch and making his devote a certain amount of time to simply flat beading. However, there is training of intrinsic value in this, inasmuch as it gives the student the necessary swing of the torch and easy manipulation of the filler rod. This having once been mastered, the welding together of two pieces becomes easy. The writer has tried both methods, first giving each student a flat piece and other students two pieces to weld together, and in every case the student who has spent time on flat beading advanced for more rapidly than the other men. Flat beading, besides giving a man the ease and familiarity of working his flame and filler rod together, also imparts the lesson of real fusion.

In addition to having complete equipment, a successful welding school must be in charge of a man who can demonstrate the actual weld and be able to impart his knowledge and supervise the students. A great many skillful welders seem to lack this ability, or perhaps not lacking it, feel that they are hurting themselves and are reluctant to impart any of the skill and knowledge that they themselves have acquired. This feeling is quité evident to any welder who has been welding six or more years. The writer well remembers one shop in which he worked while looking for experience, where the crack welder of the shop immediately put out his torch when other welders came near him, in order that they might not see or learn any of his skill.

There is another angle of the welding school and the place it should fill in any large manufacturing center. You must realize that with many acetylene firms pushing sales of their product, each sale means a welder, and the salesman's popular argument that he will send a demonstrator to teach a mechanic at the plant where the sale is made, has little or no value, because the average demonstrator has not time enough to instruct a man properly. The welding industry has recognized for several years that welding is largely an educational proposition. There are salesmen today who are calling monthly on leads two, three or four years old, knowing that the firms where they call have need of and could use the welding apparatus. They are constantly striving to educate the plants they visit to adopt it. Admitting, then, the fact that welding is in the educational stage even to the manufacturer, why should we not have a place to start at the bottom and educate the welder himself?

One more angle of the situation I wish to present is this: A great many men in various plants are "broken in" by the firm employing them to weld, and naturally learn welding from a most restricted viewpoint. Welding to them means the particular kind of welding which the particular firm who employs them uses, and after a certain number of months they feel that they are competent to call themselves welders, when, as a matter of fact, they are torch operators, highly specialized on one particular kind of work. Perhaps it might be fair to say the average student upon leaving a welding school is himself only a torch operator, but at least he has the advantage of the foregoing men through the fact that he is a torch operator on steel, cast iron, aluminum, brass and copper. There will undoubtedly be many men who read this who will smile and say it is impossible for them to be even torch operators of these metals, but my experience has been that after steel has once been mastered in its various thicknesses and vertical, horizontal and overhead positions, the welding of cast iron, aluminum, brass and copper follows on quite easily. To be sure, when taking up aluminum and cast iron especially, a great deal of care must be taken to explain properly the theories of expansion and contraction which necessarily enter into successful welding of these two metals.

The men who go to a welding school have a strong desire to better themselves and really pay welding a fine tribute in showing their faith in its future through the investment of hard-earned money to learn it. The average student with whom the writer has come in contact are men who have followed various pursuits; he tas taught butchers, tailors, insurance men, hospital orderlies, short order cooks, teamsters, chauffeurs, and so on, even men who could either not speak English at all or had a very limited knowledge of the language. In fact, every type of man has been met and dealt with. Due to the fact that the men who come to a welding school do differ so widely in their previous training, it is essential that the problem of teaching them reverts itself into a question of "personal" teaching. While various lectures may be given to them as a class, individual attention is more

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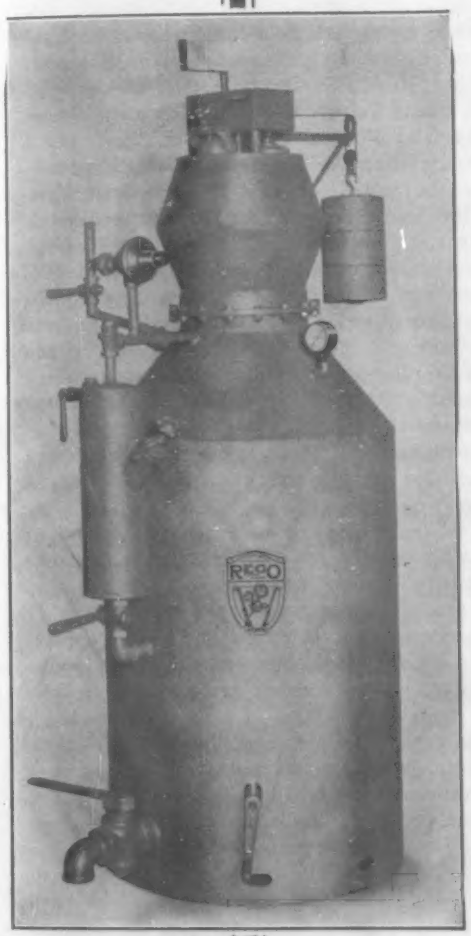

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Name .....

Address .....

essential as the instructor must present knowledge to each student in such a manner that he will understand it, and leave opening for individual questions on the part of the student as to what he does not understand.

Another criticism generally heard is that students cannot learn to weld on scrap. My answer to this is: They can. It is hard to get a man to work on something he knows is scrap and do his best on it, but this can be overcome by making the man, after completing his weld, take his piece to a sturdy vice or "V" block and breaking same with a hammer until he makes a perfect weld. In inconvenience and annoyance of breaking the pieces makes him exert his best efforts to obtain a piece which cannot be broken and thus pass on to the next exercise.

Another thing is the spirit of competition which enters into the school. In the case of three of four men working side by side, naturally none care to be the slow one and each strives to make a little faster progress in his work than the man next to him. The writer has had some fifty student welders pass through his hands the last six months; in almost every case the student upon completing his welding course has gone out into the welding field in some industrial plant or welding shop, and has successfully held his job. There are a few unusual cases where men have even obtained more money than older welders within a few weeks. This, to be sure, is not so much to the credit of the school as to the student himself, but the fact remains that had it not been for a welding school giving this man a start, he would not have been in position to do what he did.

A great deal has also been said upon the cost of running a welding school. The writer fully agrees that it is pretty hard to make up a comprehensive welding course for popular prices of $65.00 to $75.00, but maintains that although difficult, it is possible, providing the school is run along conservative and legitimate lines. Welders, like every one else, for various reasons quit their vocation, and also sometimes have to die, and if the field is not constantly kept supplied with new recruits with a reasonable welding knowledge, where are the future welders coming from?

WELDED PRESSURE VESSELS

An Investigation Contributory to the Boiler Code Committee of the American Society of Mechanical Engineers

ONE of the many difficult problems concerning the Boiler Code Committee of the American Society of Mechanical Engineers in its effort to draw up satisfactory codes governing the construction of unfired pressure vessels was that of welding. Rules applicable to riveted constructions do not always apply to fabrication by welding.

The problem is seriously complicated because of the meagreness of scientific data upon which to base proper requirements for safety without placing unjust restrictions on the use of welding. Wide differences of opinion prevailed not only amongst the members of the Committee, the insurance companies and inspectors, but also in the industry itself.

A hydrostatic and hammer test was finally proposed for determining whether a vessel was safe for the purpose designed. The American Bureau of Welding, which is the advisory committee on welding research for the American Welding Society and the National Research Council, organized a Pressure Vessel Committee to co-operate with the Boiler Code Committee in determining the adequacy of the test proposed. Eight manufacturers placed at the disposal of the committee some forty tanks and enough funds. These tanks have been tested to destruction by the U. S. Bureau of Standards.

The shells of most of the tanks were 6 ft. long and 2 ft. in diameter, and made of ¾-in. mild steel plate. Both electric and oxy-acetelyne welding were used. The hydrostatic and hammer test developed that the welded pressure vessel, according to the regular formulas for working pressure, has a factor of safety of about 6.

A remarkable feature of this undertaking is the rapidity of accomplishment. The first meeting of the committee was held in New York on August 17, and a plan outlined. The tanks called for in the program were immediately built by manufacturers distributed widely (one of them on the Pacific coast) and shipped to the Bureau of Standards in Washington. Most of the tanks arrived by the first of December. Under the supervision of Dr. H. L. Whittemore, chief of Section VII-1, Physical Tests of Structural Materials Division, who is also chairman of the committee, testing was started December 4 and carried on continuously to January 10. Many visitors, including members of the Boiler Code Committee, insurance inspectors, tank manufacturers, American Welding Society and National Research Council, have witnessed tests. A report is being compiled and will soon be published. This program, including tanks, testing and incidentals, involved a sum of $15,000.

The manufacturers co-operating in this work are: York Manufacturing Company, Pfaudler Company, Elvira Enameled Products Co., Union Carbide & Carbon Corp., DeLaVergne Machine Company, Coast Culvert & Flume Company, Brunswick-Kroeschell Co., and Vilter Manufacturing Co.

Cooperative Effort to Solve Welded Rain Joint Problems—

American Electric Railway Association and American Welding Society with National Research Council, have united in an authoritative investigation on various types of welded rail joints in commercial use. A Committee on Welded Rail Joints was organized early in 1922, has developed a program, secured financial support, and has experimental work well started on a large scale.

The statement is familiar to all "that the life of the track is the life of the joint." It is also true "that the life of the pavement is the life of the track."

Besides the indirect value of good joints, the direct cash expenditures on account of the bad ones are so great as to comprise a large proportion of the expense of the Way Department. The welded rail joint as a general type gives promise of ultimately greatly lessening track maintenance cost, but at present is being installed with few or no scientific data as to correct precedure. Moreover, the welded type of joint offers large savings in the electrical and power departments. First cost of bonding is avoided and the steady drains due to waste of power and low voltage are practically eliminated if the joints remain good.

Welding processes are highly technical, and owing to their comparative newness, application to rail joint manufacture has not yet been thoroughly worked out.

The solution of the problems involved require co-operation on a large scale. Electric railway companies all over the country are installing thousands of joints every year, in many cases using methods and variations in processes which have been tried elsewhere and found unsatisfactory, or the ultimate effects of which are entirely unknown.

Following a plan adopted by National Research Council in attacking other problems, a committee was organized including members from electric railway companies, rail and equipment manufacturers, and technical laboratories. The aims of the committee are: (1) To determine the present state of the art. (2) To improve upon existing practices by the aid of all obtainable knowledge of the subject. (3) By carefully directed scientific tests and experiments to learn the best way of making each type of welded rail joint.

In order to compile a summary of the present state of the art, a questionnaire was prepared on the four types of joints in commercial use. Answers to the questionnaire were correlated and a progress report of 73 pages printed. Typical problems needing further investigation were also included in the report.

The work outlined in the program developed by the committee will involve a sum of the order of $80,000. Co-

operation has been offered from all sides; the rail manufacturers will furnish rail for testing purposes, electric railway companies and rail joint manufacturers will furnish joints for testing, the U. S. Bureau of Standards, Purdue University and University of Illinois will supply laboratory facilities. Some cash expenditures are necessary, and $20,000 has been placed at the disposal of the committee by the American Electric Railway Association and the following companies:

Boston Elevated Railway.
Chicago Surface Lines.
Cleveland Railway Company.
Community Traction Company.
Connecticut Company.
East St. Louis Railway Company.
General Electric Company.
Illinois Traction Company.
Indianapolis Street Railway Company.
Louisville Railway Company.
Metropolitan West Side Elevated Railway Company.
The Milwaukee Electric Railway and Light Company.
Pennsylvania-Ohio Electric Company.
Philadelphia Rapid Transit Company.
Public Service Railway Company.
Terre Haute, Indianapolis & Eastern Traction Company.
Third Avenue Railway Company (Dry Dock East Broadway and Battery R. R. Co.).
Union Traction Company of Indiana.
United Railways of St. Louis.
Westinghouse Electric & Manufacturing Co.
Metal and Thermit Corporation.

To supplement the tensile, drop, repeated impact and conductivity tests, a rotary service testing machine will be built at the Bureau of Standards, in which the joints will undergo wear in one month similar to that which they would receive in ten years of service.

Rails have been shipped by the steel companies to the street railways and manufacturers who are to make up the test joints. Progress has been made in the design of the rotary service testing machine. A number of very interesting factors enter into the design of such a machine, among which may be mentioned the enormous centrifugal force which will be developed, the effect of sprung and unsprung weight, the question of braking, whether flanged or flangeless wheels shall be used, whether the track shall be curved uniformly through rails and joints, or whether the joints should be straight and additional curve given to rail on either side, and the manner of constructing and safeguarding the observation pit.

Progress has also been made in standardizing methods of making other physical tests.

The officers of the committee are:

Chairman: George K. Burgess, Chief, Division of Metallurgy, Bureau of Standards, Washington, D. C.

Vice-Chairman: E. M. T. Ryder, Way Engineer, Third Avenue Railway System, New York.

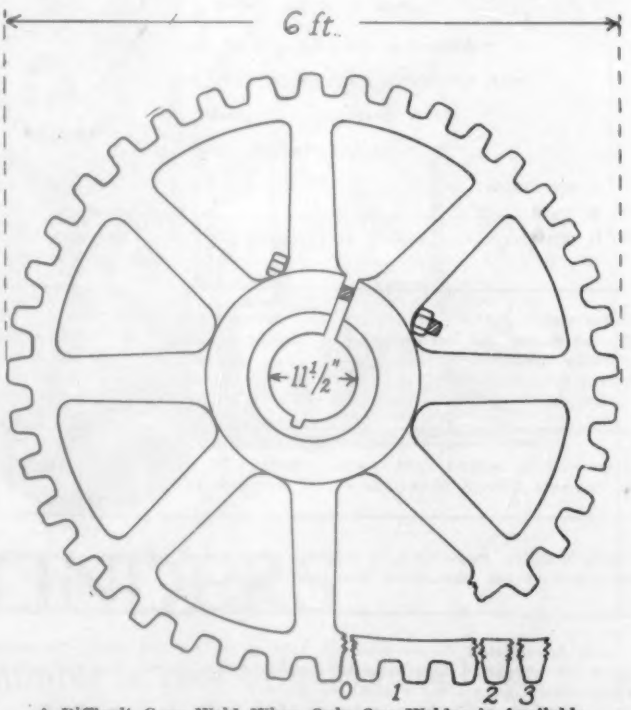
Secretary: William Spraragen, Secretary, Division of Engineering, National Research Council, 29 West 39th Street, New York.

WELDING A BROKEN GEAR

By E. F. Hawkins

A little while ago I was called upon to weld a broken gear which was part of a 170 in. paper machine. The break occurred after the bearing surface had worn down to the place where it was meshing too deeply. When the break occurred it was immediately taken to the company's blacksmith shop where we chipped it out in preparation for the weld, beveling it about 45 degs. I welded pieces Nos. 2 and 3 first, then took piece No. 1, preheated it, and welded it to the piece I had made by welding two and three together, then set it up ready to weld this solid piece to the whole gear at point O. I was the only welder on the job, and we had only one welding torch. I believe it would have been easier to have done the job with two welders on it. I got along pretty well by having the blacksmith help me out. He preheated the gear with a home-made kerosene torch, which operated with 110 lbs. of air pressure. It took us about three and one-half hours to preheat it, as we had no furnace, and there was no room in the shop to build one.

When I welded piece No. 1 I left the end at No 3 a good 1/16 in. low. When this end started to cool it had raised exactly



A Difficult Gear Weld When Only One Welder is Available.

in line for welding No. 3. I then kept the preheating torch at the first piece, and kept on welding No. 3. This was the last weld we had to make on the job, and was the one which would decide whether there would be any warping or cracking. I used carbon blocks on the sides to hold the metal. When the job was finished the parts were all well aligned, and we had no trouble whatever with warping or cracking.

WELDING IN MEXICO

Editor:

Have just read your interesting offer of prizes for descriptions of difficult jobs and how they were done. Unfortunately, things are more or less routine, here in Mexico, but when faced with any difficult proposition we follow the advice of Dr. Coué, and have found it invaluable.

In the accompanying sketch, which is a bit rough, due to the fact that my wife is using the drawing instruments to design a new tamale, you will note how we solve our problems by Couéism, here in the land on Mañana. The boys can have it for what it is worth—or, less.

Lewis J. Cullen.

The Welding Engineer

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Pressure Work Calls for Expert Welders

ONE manufacturer relates an experience on the hiring line which seems to be a record for careful selection. The welding on some refrigerating apparatus called for the services of two men. Advertisements inserted in local papers brought thirty welders to the plant and all of them were hired. They were hired on a "make good" basis, and only two of them lasted longer than two weeks. In all, it cost over a thousand dollars to secure the services of two expert welders. That looks like an expensive labor problem. The other side of the story is that in more than three thousand pressure welds completed only two pinhole leaks were found, the welds having been subjected to an air pressure of three hundred pounds, under water. It was worth all it cost to get started on this job with the right kind of men because welds on refrigerating machinery have to be first quality. A carbonized or oxidized weld in ammonia pipes will mean a certain failure in service, and careful selection of operators is the most important step toward getting a clean, sound weld.

A Practical Test for Welding Wire

WHEN one variety of welding wire is giving acceptable results in the shop, it seems unnecessary to consider such a thing as changing to another kind of filler material, no matter what advantages are claimed for the substitute. At the same time the welder hates to think that he may be losing just a little by not making the change. An actual working test is about the most satisfactory way to reach a definite conclusion as to the wisdom of changing. Let the welder make up a sample with the new wire, put it in service and observe it carefully for a period of months. Then he will probably know which is best for his purpose. Such a test requires much more time and delay than the popular tensile tests, etching tests, etc., but it has the virtue of showing up the vital facts.

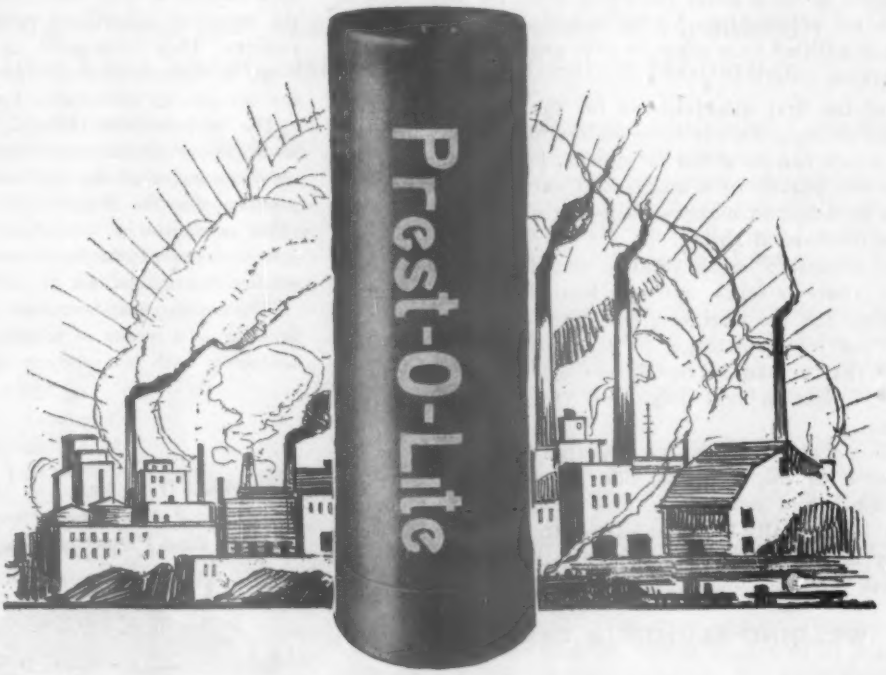
Where to Get Good Welders

ONE difference between the foxy foreman and the one who is asleep at the switch, lies in their methods of getting new welders. The former looks ahead, foresees the demand for good welders, and immediately gets busy making them to order from the best raw material he can get; the latter just takes a chance, occasionally catching a good man by accident, but usually finding it difficult to expand the welding department without an excessive labor turnover. The best welding departments are constantly training new men, and seldom have to depend upon outside sources for help in filling vacancies.

What a Railroad Foreman Thinks

A GOOD many of the railroads have been obliged to make a complete reorganization of their repair departments since the labor trouble and the gradual increase in activity in the shops has made it necessary to break in hundreds of new welders on railroad work. Many of the old railroad welders have drifted back to their jobs, but some of them have found better ones, and some of them have quit welding for other trades. The present situation makes the task of the welding foreman particularly difficult. He feels very fortunate, indeed, if he can make his superior officer understand that welding is an operation calling for considerable skill. The point of view which they are trying to place before the department heads is pretty well covered in the following letter from the foreman in a railroad welding shop.

"It has been the experience of the writer that most men who attempt to break in welders on railroad shop work, give practically all their attention to the subject of the manipulation of the torch and rod. In other words, the wrist movement is the only thing they consider necessary to master, in order to become an expert welder.



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"Of course it is admitted that the proper wrist movement is essential to successful welding, but it is also true that if a man expects to do a good job every time, he must be able to give a lot of attention to the technical side of welding. Welding is entitled to a place in that group of trades which require brains.

"One of the first qualifications for the beginner must be mechanical ability. This is more important than any previous training which can be given in schools, because the welding problems are usually of a mechanical nature. It is not fair for us to be asked to make welders out of men who do not have this mechanical ability.

"Other necessary qualifications are inquisitiveness and honesty. There is much more to learn than the instructor can possibly tell the beginner, where the new man must be reaching out for knowledge on his own hook. It also is necessary that a man be honest enough so that he can be trusted to make a real job every time without careful watching.

"We should also be given an opportunity to teach the beginner some of the technical side of welding. There are many foremen and supervisors, and even officials of companies who do not really have the least conception of what welding really is. We need an opportunity to get together and study these things."

WELDING ALUMINUM CASTINGS

Editor:

We made good results in welding aluminum crank cases by the following method: We take the broken crank case and fit the broken pieces in place so that they line up. If possibly a piece is missing, a piece of 16 or 18 gauge iron is cut to fit the inner surface. We then make a cast form of plaster and asbestos fibre, half and half, using the burned or brittle paper which comes off other welding jobs. The moistened asbestos paper is rubbed into a mush, and the plaster added, then the aluminum casting which is to be welded is lined about 1 in. thick and it is allowed to set until firm, and it then will be ready for preheating and welding.

When the preheating is done in a sand box, there is less danger of sagging, because the sand will give a uniformity to the casting. We believe in using plenty of preheating, and using a small torch to do the welding, because if we can keep the heat even there is less danger of spoiling the job. We never try to cover a casting while preheating it, or to preheat it from the end, because the preheating runs very quickly.

By using a mold, as described above, we can work right through the fracture and work from one side only, starting in the center and going on to the edge, working about 3 or 4 in. at a time. With practice a man can weld in a vertical position, or build up a flange almost as easily as a plumber uses hot lead on his work. We advise keeping all drafts away from hot aluminum, and keeping some preheating fire at work while the welding is going on.

J. G. RICHARDSON.

A WELDERS' CONVENTION IN OKLAHOMA

One sure method of bringing welders together for a convention is to announce a barbecue. The barbecue was the drawing card held out by Willard Foster, of Tulsa, when he decided last fall to have all the welders of the territory adjacent to Tulsa come to the plant of the Tulsa Oxy-Hydro Company for a day of eating and learning.

The day was a success, if a gathering of 300 men interested in welding can be classed as a success. All were not welders. There were purchasing agents, whose concerns buy welding material. Tulsa city officials were present. And a few of the gathering were friends of Mr. Foster and his salesmen.

But most of those who gathered at the Tulsa plant were welders. After they had heard all the talks on welding, witnessed the several demonstrations and eaten their fill of barbecue, they took matters in their own hands. They took hold of the apparatus provided and staged various contests in both welding and cutting. They tried some of the ideas given them during the talks, and demonstrated various abilities of their own, making the day one of exchanging knowledge of welding.

The barbecue was old-style in all its features. An Oklahoma steer, whose displacement ran close to 700 pounds, was cooked on the scene, a pit having been dug outside the canvass inclosure provided for the demonstrations. Besides the barbecue, all the other necessities of a complete meal were served. There were refreshments of the liquid variety, due respect being taken of the legislative activities of one Mr. Volstead.

The one-day demonstration was conceived by the Tulsa manufacturer as a means of acquainting his customers and prospective customers with his products and the methods of their manufacture. Accordingly he sent letters to these customers, and his prospects. He invited them to come and made it plain that they might bring their friends.

W. C. Foster Carves a 700-pound Oklahoma Steer on the Occasion of His "First Annual Opening."

Out at the plant in West Tulsa, Fred C. Heppel, sales manager of the company, was master of ceremonies. He marked off a space of sufficent size behind the plant and had it inclosed within a canvass wall, six feet high. Tables for the barbecue, demonstation benches, a platform for the speakers and seats for the visitors were provided inside this canvass. Special provision was made for a display of "Meco" welding equipment of the Modern Engineering Company, for which the Tulsa firm is distributor.

There were several demonstrations and contests, some planned as a program for the day, others resulting from the discussions. A test was made as to purity of gases. The gas manufactured by the Tulsa firm showed 99.7 pure.

The demonstration that held the spot light place on the program was that of cutting metal bars, an automatic cutting machine being used in order to offset the human element in the test. A bar 3 feet, 5 inches long, 1¼ inches thick, was cut its full length in 2 minutes flat. Measurements made following this showed that but 12 feet of gas had been required to make the cut.

Methods of manufacturing all sorts of gases were explained and demonstrated by a visit through the plant. After the explantion of the methods of hydrogen manufacture, some special demonstrations were given in the use of hydrogen for cutting purposes. Metals of various sizes and thicknesses were used in this demonstration.

L. A. Kelley, of the firm of Kelley & Dempsey, welding contractors of Bartlesville, Okla., made a talk on the methods of welding oil and gas carrying pipe lines. Points of his talk were demonstrated with the gas and equipment on hand for the demonstration.

Mayor H. F. Newblock, of Tulsa, made an address of welcome to the visitors. He was followed by Mr. Foster, who told his guests they were there to make themselves at home.

I. F. Fausek, of the Modern Engineering Company, of St. Louis, was among the guests. He spent part of his time aiding in the demonstrations of equipment made by his company and sold by the Tulsa firm.

PRIZE WELDING STORIES

Preheating Table for Welders — Welding a Cracked Knuckle in a Flue Sheet—Repairing Malleable Housings

JANUARY PRIZE STORIES

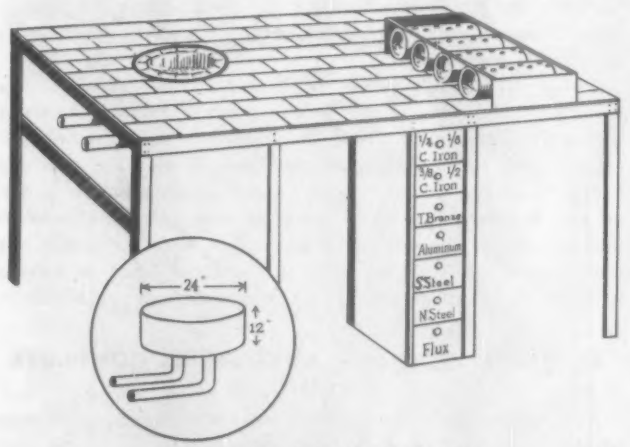
The following three stories have been selected from those submitted in response to our advertisement plublished in the January issue of THE WELDING ENGINEER. Announcement of the prizes awarded for the stories in the February issue will be published next month. In all cases the awards have been made on the basis of the practical value of the instruction contained in the story, from the point of view of the man who desires to accomplish a similar job.

FIRST PRIZE

M. Whittaker, Kentucky

A PREHEATING TABLE

These suggestions show the details of a combination welding stand and a preheater of my own design and make. I have never seen anything exactly like it in any other welding shop, so a good many job welders will probably be interested in it. The cost of material required is small in comparison with the cost of a ready-made preheater, because it is made of material which can be bought at the junk price. The only new articles necessary are two hulk kerosene burners, and some ten gauge iron for



A Preheating Table for Welders.

making the oil tank. When I made my own table I bought new burners and made my own tank.

Note that one end of this table is used to hold an oven where I preheat heavy castings and wheels which require a lot of heat without much expense. The oven is filled with coke and the two kerosene burners supply additional heat through the pipes. At the very end of the table is a space for preheating cylinder blocks and crank cases. This was made by cutting 6 in. pipe in four lengths 16 in. long, laying them side by side and welding them together, then cutting a lot of holes in the top. Each pipe is filled about one-half full with broken fire brick. The small sketch of the coke oven shows what it looks like before it is put in place in the welding stand. The pipes in the bottom are 4 in. black iron pipe covered with asbestos. A shell is made of 10 gauge iron. It is lined inside with fire brick. The cement was made with fire with a little salt added to the water.

The cylinder block heater is so arranged that the burners can be changed from one to another, getting the heat where you want to by placing the block on top of the pipes which are filled with holes to allow the heat and glaze to come through. The pieces of crushed fire brick hold the heat nicely, and also help to accomplish a slow cooling of the casting. Since I have been using this cylinder block heater, I have not had one crack on cooling. The very end of the 6 in. pipe is, of course, stopped by an iron plate with the fire brick lining. I always cover these castings with asbestos paper after lining.

The bottom of this stand is covered with corrugated iron, such as used for building purposes. I use a double layer of it so as to get extra strength. On top of the iron I have a thin layer of sand, then a layer of fire brick. I am careful to keep this as level as possible.

The lined oven heater when filled with coke and carrying the heat from two burners placed in the pipes at the bottom makes a very quick heat a small cost. The two pipes which carry the burners are covered with asbestos so as to prevent the loss of heat by radiation.

There is a whole lot of convenience in the row of metal drawers for holding filler rods and fluxes, especially if the welder is careful to keep each kind of rod and flux in its right case.

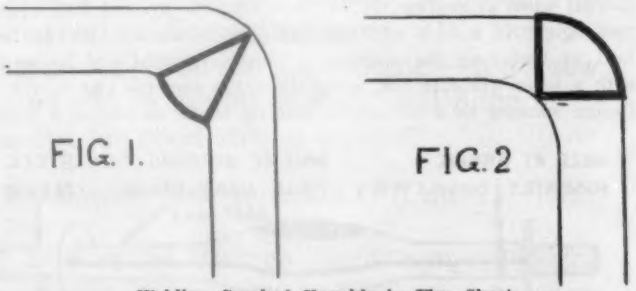
Your readers might be interested in a little experience we recently had in welding ammonia pipe in an ice plant. The pipe was about 1½ in. from the bottom of the tank, and was broken entirely in two. As one end of it was fastened to a motor it could not be removed without great expense. The pipe could not be turned in either direction, and on account of its position it was impossible to get the torch under it. We knew that we had to make a weld here because the pressure was so high that brazing would not do. I finally decided that the way to get at it and do a good welding job was to saw a piece out of the top, then make my weld and replace the piece, welding it in from the outside. This system worked fine, and the piece is giving good service.

SECOND PRIZE

A. W. Young, Michigan

WELDING CRACKED KNUCKLE IN FLUE SHEET

Sometime ago I read a long, well illustrated article on the subject of boiler welding. One of the pictures showed a cracked



Welding Cracked Knuckle in Flue Sheet.

knuckle in a flue sheet, and the instructions said that this was not to be welded. If the ordinary methods were to be used on the job, I would agree with the authority of that article and say don't. Let us see why the general procedure is unsatisfactory. Some welders V out the crack if it is a short one, and do not remove any patch bolts, so there is no provision here for contraction. Some V out the crack with the cutting torch, making an opening ¼ in. wide so a welding rod can be shoved through it, then the patch bolts are removed and the crack welded. When the job is cooled off it will be found that the ¼ in. of material which was cut out has drawn together, pulling the patch bolt holes just that much out of line with the holes in the ground sheet. Then the holes in the flue sheet have to be cut out. After all this work has been done it will seem that all the contraction has been taken care of, but this is not so. At the end of the crack there is always a string which will eventually start the crack open again.

Now let us consider another method and decide whether we

are to weld from the inside or outside. If you were building an arch, upon which side would you put the key stone, the under side as shown in figure one, or the upper side as shown in figure two? Since the boiler pressure is from the inside, re-weld from the inside as figure two shows, then the pressure cannot force the metal through. V out the crack, being careful not to cut entirely through the knuckle, but leaving about 1/16 in. at the bottom. Then in making the weld reinforce it a little to make up for the metal which was not cut out at the bottom. It is better to take out the patch bolts, then you will be sure of taking care of contraction. Since the expansion occurs just and since the bottom edges of the sheet are already together, it would appear that the expansion would tend to raise the weld, and that contraction would tend to draw it together in place. Since the bevel was not made all the way through, there will not be any pulling strain or pucker at each end of the crack. Also, the patch bolt holes will be well enough aligned so that no welding of the holes is necessary.

THIRD PRIZE

Joseph Drobt, Washington

REPAIRING MALLEABLE HOUSINGS

The constantly increasing use of automobiles is causing the job welder to find new methors of repairing, and is also making it necessary to adopt standard methods of repairs on parts which show a tendency to break. One of the most interesting electric arc repairs on the automobile is made on the rear axle housing. The tremendous vibration and shock which this particular part of the automobile must stand causes many failures. Suppose one of these housings has failed on the top and bottom seam, and also on both ends close to the break assembly. This does not often occur, but it will give us an idea how the complete job would be handled. The gas tank should first be removed as a safety precaution. Two long benches about 12 or 14 in. wide and about 2 ft. high will be a great help to the operator. It is not absolutely necessary to have four wheels on these benches, but it helps a whole lot.

Before starting to weld, all grease and oil must be cleaned off, and the parts of the housing must be perfectly aligned, and this can be done with the aid of two small jacks and a chain block. The welds of the top and bottom seams should be done first. Be careful when grounding the car to clamp the ground lead down real tight. If not, it will arc and possibly damage the car as well as bothering the operator. This first weld can be made with a 3/8 in. graphite rod, using about 125 amperes and 30 volts. Before starting to work on the housing strike an arc on a piece

WELD AT BREAK ASSEMBLY COMPLETED
WHERE HOUSING FAILS NEAR BREAK ASSEMBLY
STEEL SLEEVE
DOTTED-LINE SHOWS STEEL SLEEVE
BOTTOM SEAM AFTER BEING WELDED

Repairing Malleable Housing.

of scrap iron holding it over into the loose graphite. If this is not done the loose graphite will cause a scale over the metal to be welded. A condition of this sort hinders an operator, particularly on a bottom seam which is going to be an overhead weld, and not a bit too easy under the best of conditions. No filler rod will be necessary on this weld. Starting at the center of the housing on the bottom seam, allow the metal to flow just enough to close the opening, working as quickly as possible so that the grease will not have time to get warm and run down into the weld. When the bottom seam is completed, proceed with the top seam. If possible, remove the back cushion and take out two or three boards from under the seat. This gives a better chance to get at the weld.

After the top and bottom seams are closed, the graphite electrode can be used to V out the break at the end of the housing. Rear axle housings have a steel sleeve pressed in at both ends at the brake assembly. These sleeves very rarely break. We V out the outside housing all the way through to the steel sleeve. Of course we have taken for granted that the housing has already been all aligned, but at this time it will be best to see that this is all right before starting to make the weld. The beveling process has warmed up the housing entirely. A steel brush will clean up all the grease, leaving the top absoutely clean. You will then proceed to do the actual welding, using about the same amperage and voltage as for the seam weld, except that 150 amperes for the overhead work is better. Any good grade of steel electrode will give good results. Start welding close to the brake assembly, keeping close to the bottom of the housing until one-half way around, then start at the bottom on the other side of the housing, welding the steel sleeve and the housing together. Make the weld flush with the outside of the housing. Clean with a wire brush, remove all scale, then build up another layer over the one just finished, and make it about ½ in. in thickness over the original size of the housing. After the end welds are made weld the top and bottom seams, starting at one end and going all the way across the housing. The amount of housing on the top and bottom seams depends upon the thickness of the metal. The deposit should always be a little heavier than the metal in the housing. It is also a good practice to weld up all loose rivets.

HOW A WELDER IN PORTO RICO ADVERTISES

Mr. Rene Soulette who is the proprietor of a large welding shop in Hato Rey, Porto Rico, does some very effective advertising among his customers by using a modern desk memorandum calendar.

This calendar has a separate sheet for each day of the year, carrying a calendar of the month proceeding and the month following along with the current month, and allowing generous space for making notes. There is also on each page a little message advertising the good welding which is done at Mr. Soulette's shop. This is an especially useful advertising souvenir, because it is an article which scarcely anybody would want to lose, and is, therefore, sure to serve as a constant reminder of the services which are available.

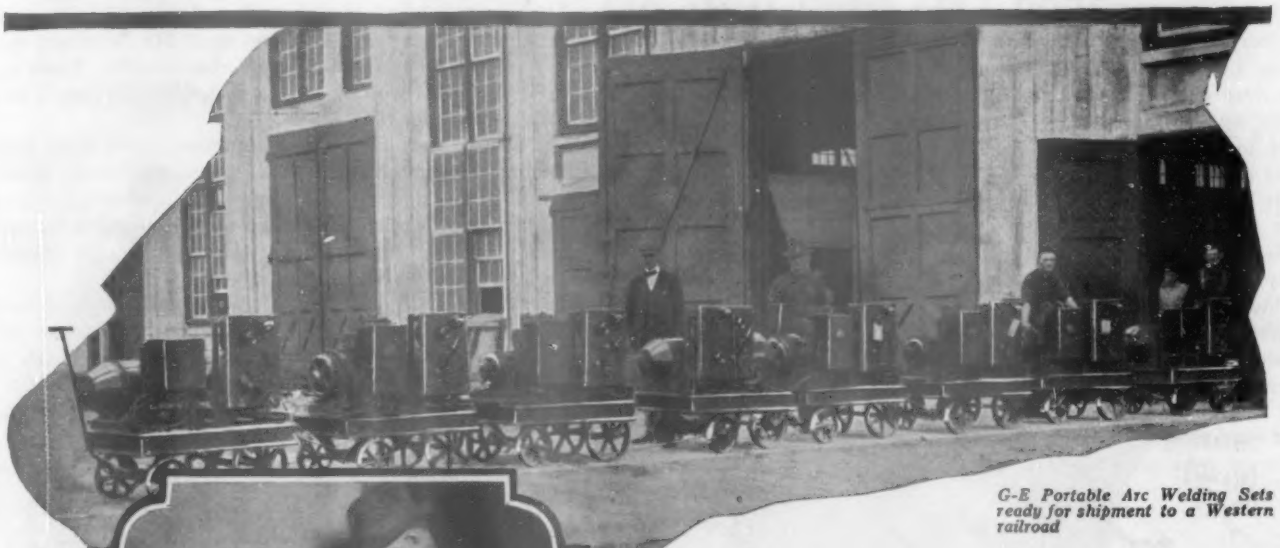
BURDETT COMPANY ANNOUNCES COMPLETE LINE

A complete line of oxy-acetylene cutting torches and regulators has recently been announced to the trade by the Burdett Mfg. Co. of Chicago. The torches include welding torches, cutting torches, lead burning, carbon burning and sheet metal welding torches, and their latest model cutting and welding torch. The trade name for this line of torches is BURCO. They operate on even pressure principle of gas mixture.

Burco regulators are also announced in a range of sizes to meet all of the requirements of oxy-acetylene welding and cutting practice. The Burco Oxygen Regulator is recommended for both welding and cutting. The manufacturers call the attention to the sensitiveness secured by using an expression and extension spring in combination, and by using a diaphragm made of a special rubber cloth.

The Metals Welding Co. of Cleveland, Ohio, has been reorganized and will be known in the future as the Welding Metals Mfg. Co. with headquarters at 4400 Perkins Ave., Cleveland. The officers of the company are: Mr. L. D. Brown, president; Mr. D. L. Britten, vice-president and general manager; and Mr. H. H. Snyder, secretary and treasurer. The new company has already arranged for a distributing branch in Detroit; also agents in Akron, Pittsburgh, Buffalo and Tokyo. Their line will include everything necessary for oxy-acetylene welding.

Give a good welder the right arc welding equipment—and just watch the sparks fly!



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WELDING BROKEN AUTO FRAMES

Best Method of Applying Patch Is Determined by the Conditions Which Caused the Break

Chicago, Ill.
Tuesday.

Dear Ed:—

In all my travels I don't know as there has been any one thing that I've seen repaired in more ways than the frame of an automobile, and the strange part of it all is, that each and every welder says his way is the best and has reasons to back him up. Says I, to myself, says I, "They can't all be right. There must be some one method of repair that outbalances the rest, so I'll keep my eyes open and try to solve this gigantic problem once and for all." It really looks as if I found the answer, so I'll pass it on to you.

It so happened that down at one of the welding meetings I got acquainted with a member who just dropped in to say "Hello!" We warmed up a bit, and I asked him up to my room. I sprung this frame proposition on him and got, what I believe is the best solution. He wasn't the oldest welder in this country; neither was he the first to bring welding apparatus to the United States, but he was a man well up in years and his manner and speech indicated that he knew whereof he spoke.

I told him that I had traveled a good bit, but every welder I had ever seen work on a broken auto frame had gone after it different from everybody else.

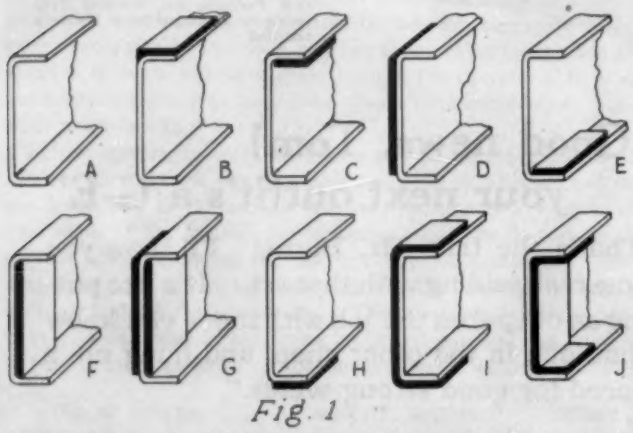

Fig. 1

Illustrating a Cross-Section of an Automobile Frame With Various Means of Applying Reinforcement Patches.

(A) Shows frame without patch.
(B) Patch applied on top.
(C) Here the reinforcement is made on under side of top.
(D) Patch is shown on outside.
(E) Inside of lower flange is location of patch.
(F) Reinforcement shown on inside.
(G) Both inside and outside patch on upright portion.
(H) Patch on lower side of bottom flange.
(I) Entire outside surface covered by this flange.
(J) Entire inside portion reinforced.

"That is truly a broad statement you are making," he said. "When you come right down to it there are only eight different kinds of patches that can be applied to a job of this nature. Of course there can be various combinations worked out, but if I may borrow your pencil a moment I'll do a little sketching for you. Here is a cross-section of an auto frame which we'll mark (A). Now let us draw the same section and show it patched on top. This we'll label (B). In this next one, instead of putting the patch on the very top as we did in (B) we'll show it on the under side of the top flange. I'll mark it (C). In this next view I'm going to draw a side patch and have it on the outside; this will be (D). Next let us indicate our patch on the upper side of the lower flange and call it (E). Then for (F) we'll show an inside upright patch. Here is another way, with an upright patch on both the inside and outside, which we will mark (G). On this next view, the patch will go on the bottom edge of the lower flange and we'll letter it (H). Now two more and all will be done. In this one, the patch is around the whole outside surface and here let us show it covering the whole inside surface. These will be marked (I) and (J). All these views show the possible location of patches. If we take away (A) which has no patch and (G) which is really a combination of (D) and (F) and shouldn't be shown, you will observe that there are only eight chances left. There can be many combinations worked out, but all summed up these I have shown are the basic ones."

"I'll agree with you; there are some mighty funny welds made on auto frames," he continued, "but you young fellows always remind me of the story about Tommy and the million cats in his back yard; that's why I made the sketches for you to show that there were only so many ways that a frame can actually be patched."

"I see your point," I said, "but it really does seem as if there ought to be a few more ways for I've certainly seen some rare ones and the point I'm getting at is: every welder you talk to insists that his is the best and only way. They can't all be right!"

"You are perfectly correct on that score," he went on. "There is a right way to do everything and a little analyzing ought to clear this problem up for you in short order; just as it would for

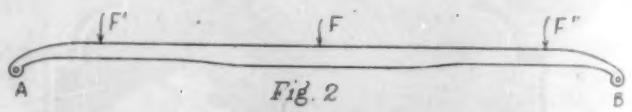

Fig. 2

Showing How Automobile Frame is Suspended Between the Points (A) and (B). All Major Forces Between These Two Points are in the Downward Direction, Indicated by the Arrows (F), (F') and (F'').

the welders, if they'd only stop to reason it out. Now to start with, we have an auto frame which is broken. Before making the repair we should first learn the cause of the break in order to effect the repair intelligently. Let us draw a picture of the whole frame and call it figure (2) and one of the same frame broken and it will be figure (3). In figure (2) the load is all located between the suspension points (A) and (B). Regardless of whether the break is occasioned by a flaw in frame or overload, it generally appears like figure (3), with the opening on the lower edge, as shown by (C). Now, the break may not be near the middle of the frame as I've shown but that is not imperative; the point to bear in mind is this:—regardless of

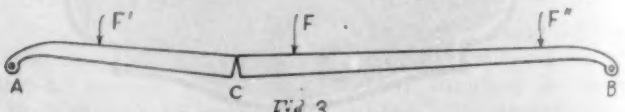

Fig. 3

When an Automobile Frame Breaks the Downward Force Causes the Frame to Separate on the Lower Side as Shown at (C).

where the actual breaking point is, whether it's in the 'horn' or the middle of the frame, the break opening is always on the bottom edge. This at once tells us where the greatest strain is, for it is naturally the part that gives way first. In this case, it is the lower edge and this we must remember.

"So far as the actual welding is concerned, I guess we all follow the same procedure," he continued. "In my own case I have six simple rules I always follow. They are:

1st. Make weld accessible.
2nd. Line up the frame.
3rd. Protect body, gasoline line and all wiring.
4th. Have all materials, including patch, on hand to complete job.

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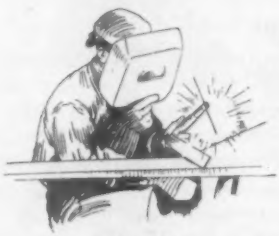
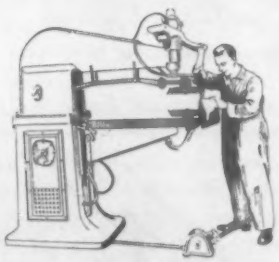


FOR THE ELECTRIC ARC WELDER



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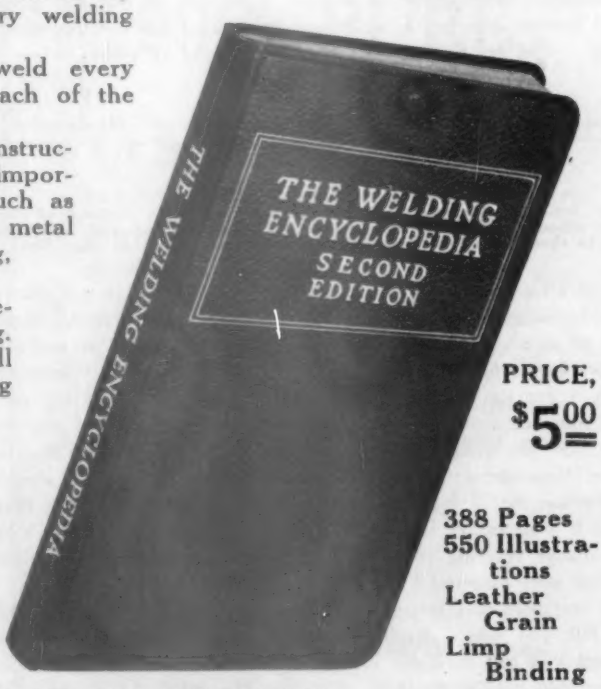

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5th. Without regard to nature of patch, the weld itself must be perfectly sound.

6th. Allow weld and patch to cool before placing strain upon it.

"With these steps as a guide I attack every job of this kind in the same manner. Sometimes of course, it isn't necessary to jack up the body. If the break is ahead of the body then the radiator or some other part may have to be removed. Whatever the circumstances may be, the part to be welded must be made accessible. Then it is reasonable to suppose that the frame be placed in proper alignment previous to welding. To protect the surrounding parts, sometimes sheet asbestos is the best insulator; at other times small broken parts of asbestos paper soaked in a pail of water, can be packed around the parts which require protection. My suggestion of being sure that all material is on hand before starting to weld may seem uncalled for but many times I find myself short of something right at a time when I

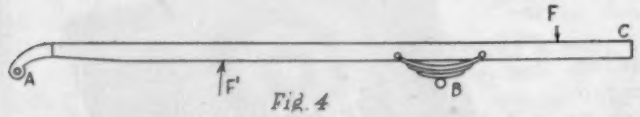

Fig. 4

On Auto Trucks (especially the dumping variety) instead of the force being down between the points of suspension (A) and (B), it is up. In such cases the frame usually separates on the top edge first.

can ill afford to stop. My fifth point is another that you might consider superfluous but many times I will have a break right at a point where a cross member or bracket is riveted on and the temptation is to depend more or less on the patch. Whenever I do, I get the job back and I know what is true in my own case must be equally true with others. That is why I say be sure that the weld itself is absolutely sound. Repeating this to myself I can turn the trick just like his highness, M. Coué, does."

"Pardon me!" I interrupted, "But do you really believe that a patch is necessary if an absolutely perfect weld is made? You are always refering to a patch; I was just wondering whether patches were essential."

"I certainly do," he responded, "in nine cases out of ten, and I'll tell you why. Regardless of how you may feel on the subject you can take my word for it that a steel weld of this nature can not be made as strong as the original. Why? I'll answer that too. A weld made with a torch must be considered as a cast fusion. You'll grant that the steel is melted; if it is, then the weld is nothing more or less than a casting. Now if this weld is made on cast steel or cast iron the fusion ought to be just as strong or perhaps a trifle stronger, than the original if a better grade metal is used but on cold rolled or drawn steel it can not come out as strong—What's that you say? Build up! Why that won't make any difference. On each end of your weld there will be a small zone where the heat has converted the close grained rolled stock into a cast or semi-cast stage and that will be the weak point. Yes, I honestly believe that a patch is the thing for welds of this nature. The only exception would be where a break occurred, due to an accident and was at a point where there was ample strength."

"When it comes to the choice of a suitable patch and it's application, that's where most welders disagree," he went on. "I suppose you are wondering which one of the eight I just sketched is my standby. I won't hold you in suspense any longer. First, I'm going to tell you my choice; state my reason and then I'll criticize some of the others for you. Style (H) is the patch I use and its batting a 100 per cent for me and that's why I'm so strong for it. Here's my reason for choosing (H):—As I explained a little while ago, when a frame breaks it always opens up on the bottom side, just like (C) in figure (3). Now the point where it opens the most must be the part where the greatest strain comes and the part that remains closed indicates that little or no strain is at that point. Following thru, I claim that the lower portion of the frame at (C) figure (3) is the part that needs help; so after welding the broken ends together, then I apply my patch along the lower side just like (H) in figure (1). I make this patch from a piece of band iron, the same thickness as the frame. It is foolish to put on a big heavy strip when a light piece will do just as well. I make my patch the same width as the bottom of the frame and from six to eight inches long. After the frame has been welded both inside and out and the place where the weld goes has been left just flush, the patch is applied. I might say here that if I ever find rivet heads interfering with my patch, I simply melt them off and weld them to the frame. In order to handle the patch and get it to fit snug, I generally "tack" it to the end of a filler rod and then swing it into place without any effort. After "tacking" the patch in position I melt filler-rod off and then heat up the patch until it is red hot all over. Now by striking lightly with a hammer the patch can be fit very closely to the frame and then welded on all four of its edges. I contend that a patch so applied will make the frame just twice as strong at that particular point. My experience has backed me up."

"I see your point all right," I said, "but you promised to criticize those other patches for me and I'm anxious to have you."

"No sooner said than done," he answered. "Let's take them right in the order I've drawn them. (A) won't do because as I explained just now it won't be strong enough without a patch. (B) has the patch where it does absolutely no good for there is very little strain on the top flange. The same thing can be said of (C). (D) is a popular position but on account of the shearing effect it does not properly strengthen the lower edge where the break always starts. Now (E) is much better than any cited thus far and sometimes its use is warranted on account of the position of the break but you can readily see that it does not give the maximum result. With (F) the same reasoning holds true as in the case of (D), and likewise with (G). (I) and (J) are other popular means employed but the whole trouble here rests in the fact that they can not be fit snug enough to the frame. On account of this, the strain comes first on the frame and that is what should be avoided."

"Your arguments certainly sound reasonable but there was one point I wished to ask you about a minute ago. You mentioned that when you were welding the frame itself that you always left the under side of the frame where the patch is to be applied, just flush. You probably are working overhead at that point; if so, will the average welder have any trouble in making his weld come out flush?"

"Rest easy on that score," he replied. "If your operator has any trouble there, all he has to do is pick up his hammer and tap the weld lightly until it is even. This of course is done while the weld is red hot. It responds very readily."

"While I'm at it, I'm going to spring another question if you don't mind. They say that it's a poor rule that hasn't exceptions. Was just wondering whether yours had any."

"So far as the average auto or truck is concerned, I can think of none at the present time," he answered, "but on certain kinds of trucks conditions are entirely reversed. Take for instance those trucks that have dump bodies. Just let me have that pencil of yours again and I'll explain it by drawing much quicker than I can tell it. Here, (see figure 4) instead of all the bearing down between the suspension points (A) and (B), most of the force is downward at the end marked (C). This naturally means that the force between (A) and (B) is all upward as indicated by (F). When a truck of this type breaks a frame it is generally the top edge that gives way first. Under these circumstances the patch is applied as shown at (B) in figure (1). That is the only exception, if it were to be called such, that applies to this method of mine."

So there you are, Ed! Another mystery solved. I'd like to tell you about some of the other things my friend related but they'll have to wait until some other time. As things stack up now I've a whale of a bunch of work I simply must get cleaned up so here goes. Yours as ever,

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EXAMINATION OF OPERATORS

Questionnaires and Tests Which Enable the Employer to Classify Applicants According to Ability

AT the March meeting of the American Welding Society, Chicago Section, held Friday evening, March 2nd, the subject of the program was "The Examination of Welding Operators." Papers and discussions on this subject were prepared by members and friends of the society in Chicago, and presented at the meeting. By consolidating these papers, and eliminating topics which were duplicated, a complete questionnaire has been developed, which includes:

(1) Questions of a general nature which should be made a matter of record in the case of every applicant.

(2) Questions regarding the process to test the applicant's knowledge of it.

(3) Questions relating to equipment and to the supplies used.

(4) Questions relating to special jobs.

The value of some of these questions was commented on freely, and a digest of this comment follows the questions.

To the employer this material will prove extremely useful, for it assists him in classifying applicants according to their special abilities and they point out to him the weak spots which he must develop.

To the welder these questions can be equally helpful. The ones which he cannot answer in a perfectly satisfactory manner suggest topics which he needs to study.

A better understanding of the requirements of a welding operator for a certain job will naturally mean that more attention will be given to the training and development of the man selected for it. The employer benefits from a reduction in the labor turnover and the welder benefits by having his abilities better developed for his job.

Papers and discussions from which this report is compiled were furnished by the following:

H. Ullmer,
F. J. Maeurer,
E. S. Hurd,
R. G. Mason,
C. C. Ebright,
O. L. Howland.

QUESTIONNAIRE FOR OXY-ACETYLENE WELDERS

A. Personal Qualifications

1. Name?
2. Address?
3. Phone?
4. Is address permanent?
5. Married or single?
6. Nationality?
7. Are you employed now, and, if not, why?
8. Where did you learn welding? When?
9. What welding experience have you had?
10. What books or magazines on welding do you read?
11. What make or makes of apparatus have you used?
12. What was the largest job you ever welded? The smallest job? What difficulties did you experience?
13. What metal do you prefer to weld? Why?
14. What sort of welding do you consider your specialty?
15. What pay do you expect?

B. General Welding Knowledge

1. Explain method of setting up apparatus, lighting torch, and adjusting flame for cast iron, aluminum, brass, copper, steel. What welding rods and flux for these welds?
2. How does the strength of the weld compare with the strength of the original piece?
3. Should welding be done while the preheating fire is kept going?
4. Why do welders wear goggles?
5. What does the flux do for the weld?
6. What difference does it make whether we clip out the bevel on a heavy casting or melt it out with the torch?
7. How can the common metals be identified?
8. Why cannot malleable iron be welded?
9. What is the melting point of cast iron? Mild steel? Hard steel? Aluminum? Brass? Bronze? Copper?
10. What does annealing accomplish?
11. Why cannot scale or slag be cut?
12. What determines the size rod to use?
13. How do you figure the cost of a welding job?
14. Name three ways to check gas consumption?

C. Equipment

1. What is meant by a low pressure system? Equal pressure? High pressure?
2. Is the cone of the flame always solid? What difference does it make to the weld?
3. Why is it dangerous to use oil on oxygen cylinders, regulators, gauges and fittings?
4. Why is a smaller hose used generally for carrying tank gas than is used for carrying gas from generators?
5. Why should tanks be kept cool in summer and warm in winter?
6. What causes gauges to freeze?
7. Why is the cone larger on low pressure torches than on high pressure torches?
8. What is the temperature of the oxy-aceteylene flame?
9. One pound of carbide makes how many cubic feet of acetylene?
10. Why does water form in the pipe lines of generator gas?
11. What is the ignition point of acetylene?
12. Why should this gas be shut off first in turning out the torch?
13. What are the impurities in this gas.
14. Can other gases be used in place of acetylene?
15. What is likely to happen if there is a leak in the acetylene hose while welding inside of a tank?
16. How fast can acetylene be used from a cylinder?
17. What is acetone?

D. Acetylene

1. What is acetylene?
2. How is it made?
3. Is it poisonous?
4. In the manufacturing of carbide why are the generators driven by water power?
5. What does an excess of acetylene do to molten metal?
6. Why is the odor of generator gas pungent, while that of the compressed gas is not?
7. Why can a generator carry only 15 lbs. pressure, when you can obtain quite a higher pressure from the tanks?
8. Why should acetylene tanks be stood on end before and while being used?

E. Oxygen

1. How is this gas obtained?
2. Why not use some other gas?
3. What would happen if a person were put into a large tank filled with oxygen?
4. What happens when one welds inside of a closed tank?
5. How many cubic feet in one pound of gas?
6. Why do metals scale on being heated very hot?

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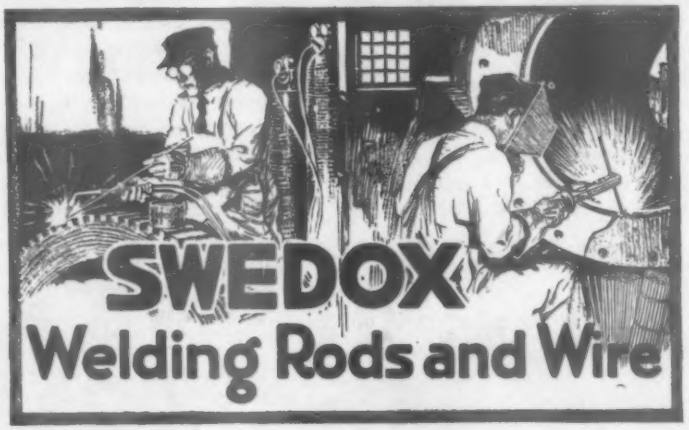
LEKTROX SWEDOX
GAS CARBOX
ARC CARBOX

VANOX
NICKOX
KROMOX
RAILOX
CASTOX



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7. What is rust?
8. What really happens when an excess of oxygen is used in weighing?
9. Why is so small an amount of liquid required in fire extinguishers?
10. How is the size of the cutting tip determined?
11. What is the use of oxygen in oxy-acetylene welding?
12. Can oxidized metal be restored to its former properties?
13. Are the impurities in oxygen detrimental to welding?
14. What causes rust to form on the inside of oxygen cylinders?
15. How does a regulator work?

F. Sheet Metal

1. If work is on sheet metal have the man set it up preparatory for welding.
2. Sizes of tip required.
3. Choice of adding material, flux, etc.
4. Method of welding whether forward, back hand, or for strength, finish or what?
5. Method of avoiding streess or strain or distortion in

F. Sheet Steel

1. If work is on sheet steel have the man set it up preparatory for welding.
2. Sizes of tip required.
3. Choice of adding material, flux, etc.
4. Method of welding whether forward, back hand, or for strength, finish or what?
5. Method of avoiding stress or strain or distortion in progress of work or afterwards.
6. Can rigid fastening be used to hold pieces in place for welding? Why?
7. Can heat treatment be applied to advantage? How?
8. If on riveted boiler seam does welding finish the job? What should be done then? What test may be used in this case?

G. Heavy Steel Welding

1. How strong can a flush butt end weld be made in reference to the original piece? Why?
2. If added material of greater strength or better quality is used, how does this affect the results of the above?
3. Can an automobile steering knuckle be welded?
4. How can small pieces of tool or alloyed steel be welded? Could this be done without drawing the temper, and if so, how strong will it be?

H. Cast Iron

1. How does cast iron differ from steel welding?
2. Can successful cast iron welding be done without flux?
3. Can steel rod be used on cast iron, or vice versa?
4. Can confined sections of cast iron be welded by local preheating? Mention specific cases such as radiator sections or spoked wheels.
5. How to proceed to weld a grate bar. What may be used for flux in this case?
6. If a cast iron piece is warped how can it be straightened?
7. What causes hard spots in cast iron?
8. What causes blow holes in cast iron?

I. Aluminum

1. How is sheet aluminum set up for welding?
2. What may be used for added material?
3. What kind of flux used? (State physical condition, dry or moist, etc.)
4. What mechanical treatment may be performed afterwards if warpage occurs in welding?
5. What flux is used with cast aluminum?
6. Describe advantages of using drawn or cast rods on either drawn or cast aluminum welding?
7. Should preheating be done on cast aluminum locally or generally?
8. Describe method of determining amount of heat necessary for preheating?

J. Brazing Copper, Brass, Etc.

1. Can blow holes be avoided in welding or brazing copper?
2. Would such welding be successful on electroplated copper roll for printing?
3. Can welding rod of greater hardness or higher melting point, be used on copper or brass successfully?
4. Is flux required in welding copper?
5. How many times can a welded or brazed section be melted over, in copper or brass? What results?
6. How are pieces of metal of different nature usually joined?
7. How about the strength of such a weld?
8. Why is it better to use too large a tip than too small a tip when welding brass?

Tests

1. Have welder take disassembled outfit, set it up, and start the weld, selecting his own tip, adjusting pressure and flame to suit himself, and picking out his own filler.
2. For production work, have working samples, that is, pieces identical with those encountered in production, and apparatus ready. Let him weld two samples. Test to destruction and examine.
3. Have applicant make plain butt weld on plate steel and give bending test.
4. Have applicant weld sample of metal to which he claims to be most accustomed.
5. Have applicant work for two days beside the best welder in the shop.

QUESTIONNAIRE FOR ELECTRIC ARC WELDERS

A. Personal Qualifications

Same as for oxy-aceteylene welding.

B. General Welding Knowledge

1. Explain the procedure of setting up apparatus, making connections, and striking arc.
2. How does the strength of the weld compare with the strength of the original piece?
3. When should arc welds be preheated?
4. Why are shields or helmets necessary?
5. What is the purpose of the flux coating on some electrodes?
6. What is the difference between a flux coated electrode and a slag coated electrode?
7. Can carbon arc welds be made as good as metallic arc welds?
8. How do you bevel for arc welding?
9. Can malleable iron be welded with the arc?
10. How can the common metals be identified?
11. What are the melting points of the common metals?
12. Why do we anneal welds?
13. How do you figure the cost of a welding job?
14. How do you determine the size of wire and amount of current for each job?
15. What welder do you prefer, and why?

C. Equipment

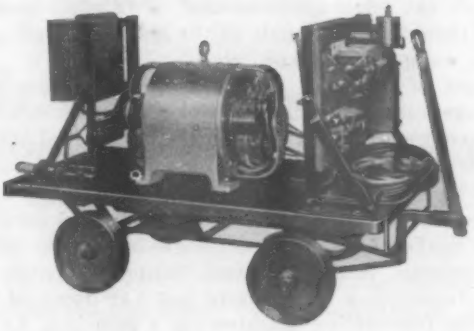
1. What is the difference between a. c. and d. c. arc welding? Which do you prefer? Why?
2. Is any more heat supplied to the parent metal in carbon arc welding than in metallic arc welding?
3. Is the welding current dangerous? Why?
4. What is the temperature of the arc?
5. What is the effect of a heavy intermittent load on the power line?
6. How is the arc used for cutting? To what extent?
7. What is meant by "reversed polarity"? When is it used?

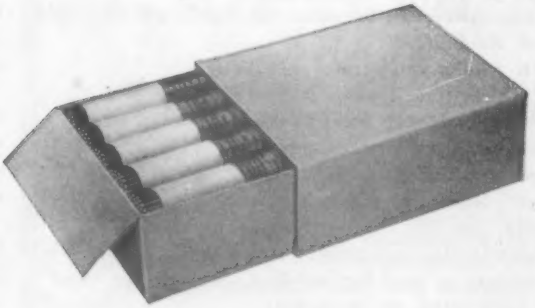
D. Electricity

1. What is a closed circuit?
2. Why must the ground connection be kept clean and bright?
3. Why do we reduce the current when we change to a smaller electrode?

FOR ARC WELDING

Cast Iron
Malleable Iron
Steel
Brass
Bronze
Monel Metal





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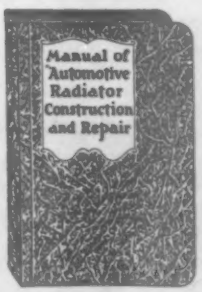

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4. What effect will a dirty commutator have on the welding current?
5. What is a transformer?
6. What is induced current?

E. Sheet Steel

1. How will you prepare for welding and set up the longitudinal seam in a cylindrical sheet steel tank?
2. What current would you use? What electrode?
3. Method of electrode manipulation?
4. How would you avoid buckling?
5. What is the difference between the rigid and non-rigid systems of welding?
6. How much would you reinforce? Why?
7. How can you test such welds for porosity?

F. Heavy Steel Welding

1. How much beveling is necessary?
2. How would you make bevel?
3. How much would you reinforce?
4. How strong can one of these welds be made?
5. Will preheating do any good? Annealing?
6. What procedure is used for welding alloy steels?
7. How can such welds be improved?

G. Cast Iron

1. Why are studs used?
2. Why are grooves used?
3. Is there any other way to weld cast iron with the arc except by the studding process?
4. How do you overcome the effects of contraction?
5. What causes hard spots in arc welds in cast iron?
6. What causes blow holes?

H. Non-Ferrous Metals

1. Describe a method of arc welding copper.
2. Describe a method of arc welding bronze.
3. Describe a method of arc welding monel metal.

Tests

1. Have applicant set up and connect a disassembled arc welding set, select wire, adjust current and start welding.
2. Have applicant make a tee weld in plate and test the weld to destruction.
3. Reverse the polarity and observe how long it takes applicant to discover what has been done.
4. Have applicant weld a couple of samples of the actual work he will be required to do. Observe difference in speed and quality of both welds.

Discussion of Questions and Tests

It will be found worth while to make the answers to questions in group A a matter of permanent record. This will assist the employer in getting in touch with applications at a later date, and will also save the trouble of corresponding with applicants who have not had the right experience to qualify for the work which is to be done.

The first seven questions of this group are self-explanatory. Questions regarding the training and welding experience are probably the most vital, and in case of an oral examination these questions should be followed up by more searching questions, the nature of which will depend upon the circumstances. It has been suggested, for example, that a man who has learned welding in a welding school is apt to know a little bit more about the theory than a man who has learned it in the shop, but not so much about the practice. The exact nature of the work previously done by the applicant is also very important. It is not enough, for example, for an applicant to state that he has been welding on pipe, because as one welding supervisor claims, a man who is accustomed to welding on large pipes, such as boiler carrying pipes and gas pipes, would make a failure at first welding on small pipes such as are found in refrigerating machinery. It is also advisable to get complete details regarding the welder's special preference, because he is quite likely to have a method of manipulation which would be very good on one kind of work and not as good on another kind. A questionnaire of this sort, properly used, will make it possible to get better results from new welders right from the start.

The questions included in the second group under the title "General Welding Knowledge," are typical questions to be presented to men who apply for positions as foremen on supervisors, or men who are to be given entire charge of welding operations without supervision. It is not suggested that all of these questions be used in the form of a regular examination, but a number of them have been set down here so that the employer can select questions best suited to his problems. The same remarks would apply to the questions dealing with equipment, oxygen, acetylene, etc.

Other sets of questions on the subjects of sheet metal, steel castings, cast iron, etc., have also been included, because when the requirements of a position are of a special nature, it is advisable to find out how near the applicant can come to meet those special requirements.

Of the tests suggested, perhaps the most useful consists in having the applicant set up the apparatus himself for welding, and start welding. In going through this procedure the applicant will always show very clearly just how much at home he feels with the welding aparatus. If a man is to be hired for any very careful work, it is, of course, advisable to have him weld test pieces. In such cases it is better to have the tests made on actual samples of the work which is to be done. These samples can be tested and the welds examined very carefully for penetration, etc.

CAST IRON WELDING

Editor:

Here is a little welding kink which has been very helpful to me, and which may not have been discovered by some of your readers.

In welding or building up a small cast iron surface in a large piece of cast iron, for instance, in building up a small tooth on the fly wheel of an automobile engine where the part built up is so small compared to the rest of the casting that it cools instantly, and when the torch is taken off the welder may find that the surface is hard and shiny, and hard to file. If this little part is brought to a bright red again with the torch and the flame drawn away slowly, so that the small part cannot cool instantly, the surface will be found to be soft and easy to file. Less than thirty seconds' treatment will soften any of these hard little spots which necessitate grinding and cause so much trouble. After it has been filed to shape, if you want it hard, simply heat it to a deep red and take the flame away quickly and the part will be as hard as glass in a moment.

W. F. BEACH.

WELDING IN NORTHWESTERN IOWA

A correspondent who is closely in touch with the welders in northwestern Iowa, speaks particularly of the good work done in the shop of the Pioneer Iron Works at Sioux City, Ia. Most of the welding in this shop is confined to heavy work, such as structural steel and heavy duty castings, together with the usual amount of cutting. They also have a considerable amount of production work on ¼ in. plates. In that part of the country it is necessary to be prepared to weld anything from a darning needle to a tractor engine boiler, so the welders are getting the habit of getting together as often as possible in order to find out how to get the work done better.

The Alexander Milburn Company, of Baltimore, manufacturers of oxy-acetylene equipment, have recently placed on the market a portable acetylene welding generator designed to obviate the use of high pressure cylinders. This generator is of 30 lb. carbide capacity, or equivalent of 150 cu. ft. cylinder gas. It is simple to operate, having few parts and operates automatically without a clock or motor. The steel body is welded throughout, while all parts are easily accessible.

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WELDING THIN SHEETS

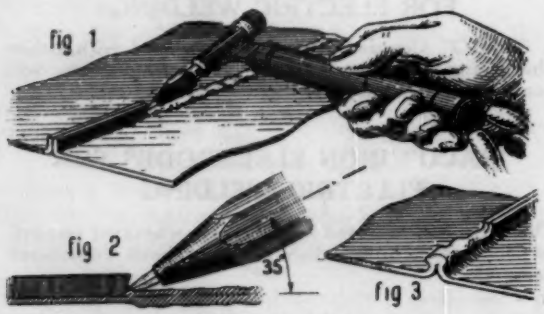
Use of Flanged Edge Makes Filler Rod Unnecessary—Preparation Must Be Carefully Made

By Marcel Piette in Revue de la Soudure Autogene

THE welding of thin sheets by flangnig the edges, although it has been known and practiced for a good many years and is recommended by some and criticized by others, has never been described and taught in a very detailed fashion. It cannot be applied in a practical way, except in the case of thin sheet metal and other thin pieces.

It seems that for the most part the utility of this method of preparation is lost on thicknesses greater than 20 gauge. For the thinner sheets, and especially for sheet aluminum, it is very commonly used, and used with success. For example, it has been used a good deal in the construction of small parts of aeroplanes and small containers of all kinds. The method is quickly adaptable to other metals, among which are sheet steel, sheet brass and sheet bronze.

The principle of this method of welding consists in securing the simultaneous fusion of little edges turned at right angles, one on each sheet of the piece which is to be welded, these two edges being previously set together very carefully and held in that position during welding.



Making the Weld.

In this way the welder gets rid of the necessity of using a filler rod which is inconvenient in welding very thin pieces. Phenomena of expansion make their efforts felt proportionately very much more on thin sheets than on thick sheets. The reason for this is that the secondary flame or envelope does not diminish in volume as proportionately as the thickness to be welded diminishes, so that the greater surface is covered by this envelope on thin pieces more than on thick pieces. Consequently, the edges are moved around more, and the distortions much more important, while the use of adding material is a more delicate task.

Using Clamps to Hold for Tacking.

Further in the welding of thin sheets, the very small thickness influenced by the welding cone makes it easier to localize the heat so that welding by ordinary methods results in burning through of a good many holes. On this account the welders often use a welding rod proportionately large so that the edges will be to some extent protected.

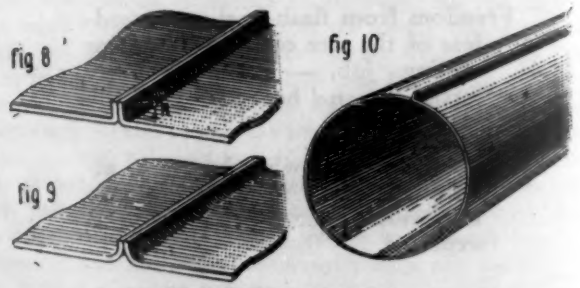
If we work by the ordinary method with the filler rod, we hold the edges together by tack welds put fairly close together. It is better to avoid making holes, because it is difficult to fill them up and the appearance of the weld is often irregular.

We can also weld together thin sheets by simply fusing unprepared edges which have been placed together. In some shops this process is common practice, but it requires a great deal of cleverness and experience with the torch. The line of welding is generally slightly concave, whereas in many cases it would be better to have a slightly reinforced weld.

In contrast to these methods, and in spite of the extra preparation which it requires, the welding by the use of flanged edges is easier and results in a better welding and a better appearance of the welded surface.

It should be noted, however, that this preparation does not justify us in dispensing with the tacking process, but if this tacking is necessary to hold the edges together it is made easier by the rigidity which these flanged edges offer, and it is also more rapidly done because of this rigidity.

Neither is it necessary to use filler metal for making these tacks. This is done by simply melting togther the edges at regular intervals, molding the welding cone almost vertical. In case the metals to be welded require the use of a flux, it is best to use a filler rod to any flux for applying it at the point where the tack is to be made. That is the only real need which we have for the filler rod in this method, except in cases where it is needed to fill up holes which were made by accident.



Sheets Prepared for Welding.

It should be noted also that we can make good use of small clamps placed at regular intervals to keep the edges close together but they ought also to be tacked. As the tacking proceeds of course the clamps will be moved ahead.

We will leave out of this discussion the question of the distance which should be left between the tacks. Ordinarily this would vary from 1 to 4 in. according to the thickness to be welded. The welder himself will learn through practice how to settle this question. The present discussion will deal with the preparation of the edges and the manner of holding the torch so as to get a normal weld. You will understand that by a normal weld we mean a weld in which the appearance of any portion and the appearance of the reverse are practically identical, showing a light convex ribbon of molten metal.

This result is secured by holding the torch correctly. The

point of the cone ought to be placed exactly at level with the surface of the sheet, as shown in Figures 1 and 2. This position allows the welder to obtain both penetration and regularity.

The angle of the torch is about 35° horizontal. If the end of the cone is placed too high the edges will not weld except on top, and although the top part of the weld will look well, perfect penetration will not be secured. The joint will not be solid and will probably show a fissure on the reverse side of the weld as illustrated in Figure 3.

But in addition to the torch manipulation, it is also necessary to pay careful attention to the preparation of the pieces to be welded. Each flange edge should be at the sharpest possible angle in order to leave but a minimum space between the two sheets as indicated in Figure 8.

It will be seen that if we secure a fusion of the proper edges as in Figure 9 we will have to fill up too much space between parts, and the metal at the edges will not be enough so that numerous holes will be produced. It is better to keep close to the essential principle of normal preparation which permits us to obtain the best results.

As far as the height of the flange is concerned, it is found to be limited to a rather narrow range. If it is too large, there will be too much metal to weld and you will run the risk of not securing penetration. If it is too small the weld will not be reinforced enough, and probably there will be frequent holes melted through. On very thin aluminum sheets the height of the flange is usually fixed at about two and one-half times the thickness. This might be measured from the top surface of the sheet. For extremely thin sheets, it is considered advisable to make this flange even four or five times the thickness of the sheet so as to obtain a fairly uniform deposit. Finally the flux is used in a special manner which works well with this method of preparation. We have already indicated that when making the tack welds, the flux was applied to the edges at the momnet when fusion commenced. A filler rod of the right metal heated on the end is plunged into the flux which can then be applied very easily to the right locality without any loss. This is a time honored method used in aluminum welding. It is equally useful for brass, aluminum, bronze, etc.

When making the weld itself on flanged edges where we do not have any filler rod to use, we need not necessarily apply the flux as the welding proceeds. The best plan is to dissolve the flux in water and apply it to the two edges before starting to weld. It is, of course, held very easily on the top, and on the lower side the small quantity necessary to accomplish a good fusion can easily be made to stick.

For the welding of aluminum sheets which are just a little too thick for the application of this process, another method suggested has been to flange one of the edges allowing the turned up material to supply the necessary metal to make a joint as shown in Figure 10.

The method of welding by flanging the edges of course interested only those who specialize in thin sheet metal welding. The only reason why it is not more commonly used is because of the preparation which is necessary. When carried out properly, this method gives the welder the greatest chance of getting a successful job.

A new oxygen plant to be built by the Linde Air Products Company, 30 East 42nd Street, New York, will consist of a main one and two-story building, 100x160 ft., and two smaller buildings. The new site is on Westfall Street, Pittsburgh.

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Current Welding Literature

BURNING OUT STAYBOLTS WITH GAS—Description of several tests to show the efficiency of the oxy-acetylene torch for cutting out staybolts. The cutting torch melts a hole in the center of the bolt a little thicker than the thickness of the boiler sheet, then a rotary motion of the hand and torch completely cuts off the staybolt inside the sheet, leaving a conical end on the cut off bolt. The shell of the old bolt left in the sheet can then be carefully removed with a hammer or chisel without damaging the thread.—The Boiler Maker, February.

STUDY OF TORCHES AND FLAMES—A study of the difference between the high pressure and low pressure torches used in France, with special attention given to the actual pressures most commonly used in welding. In the comparison of the oxygen and acetylene consumption in torches, attention is called to the fact that a number of the torches commonly used do not consume as much fuel as the manufacturers' specifications indicate.—Revue de La Soudure Autogene, January.

PRACTICAL POINTS IN RAILROAD SHOP WELDING, by E. S. Eldridge—Description of the various steps in welding a broken locomotive frame by the electric arc, with diagrams showing the method of preparation, filling sequence, etc. Corresponding instructions for frame welding with the oxy-acetylene torch. Some of the repairs commonly made on cast iron with tobin bronze arc gears, cams and cylinders. Instructions for welding fire box sheets with the electric arc.—Railway Electrical Engineer, February.

ECONOMY OF CUTTING METALS WITH THE ELECTRIC ARC, by A. M. Candy—The efficiency of the electric arc process for cutting rivets, and also for cutting steel plates into small sizes. The electric arc cutting apparatus works efficiently on cast iron and copper.—Railway Electrical Engineer, February.

WELDING SHEET METAL PRODUCTS—The story of prodution welding in a plant which makes a large variety of products from sheet metal, illustrating the value of the central welding shop. The story indicates that although welding was at first used in this factory only on unimportant joints, the strength of a good weld was gradually recognized and by degrees the process was applied to all types of seams. The welding department has been developed as an organized department, and through careful training have quite a skill which is responsible for the wide applications of welding.—Oxy-Acetylene Tips, February.

OXY-ACETYLENE PROCESS STANDARD FOR MANUFACTURER OF STORAGE TANKS—A manufacturer in the middle west who produces tanks of various designs, mainly for use in the automotive trade, and ranging in capacity from 10 gallons to 3,000 gallons, now makes all joints by the oxy-acetylene process. In actual service the welded tanks are proven universally satisfactory. The manufacturer also appreciates the flexibility and economy of his welding equipment.—Oxy-Acetylene Tips, February.

SAFETY OF DISSOLVED ACETYLENE—Although it has been known for fifteen or twenty years that under proper conditions acetylene could be safety handled in a dissolved form, there are occasional accidents which cause a lot of disturbance from people who are not well informed. Most of the accidents, according to the writer, are really due to bad quality cylinders which have exploded under normal pressure, although they have previously been tested by water pressure four times as great. In order to avoid accidents altogether, it is only necessary to really pay attention to the safety rules and regulations. The compressing of acetylene should also be subject to strict regulation.—Journal de L'Acetylene, January and February.

AUTOGENOUS WELDING IN THE PETROLEUM INDUSTRY, by K. V. King—A description of the welding practice of the Standard Oil Co. of California. First consideration is given to the welders themselves. Each one is given a careful tryout before being put to work. Filler metal generally used in low carbon steel. The ripple is used on steel plate under ⅛ in. thickness. It is common practice to anneal all acetylene welds. All welding on pressure containers is stamped by the welder with his identification number. Welding is used on containers, pipe lines, structural work, manifolds and general repairs.—Journal of the A. W. S., February.

ARC WELDING OF STEEL STRUCTURES, by F. P. McKibben—Effect of welding on designs—present practice in steel bridge construction—properties of structural riveted steel—type of steel structures—steps in building a steel structure—the welding of steel—test data on arc welding—welding operations for testing specimens—examples of electrically welded steel structures.—Journal of the A. W. S., February.

MAKING WELDED STEEL TUBING, by R. Holiakiff—Some comments on the merits of hot rolling and cold rolling. The hot rolling machine has several advantages in that it is simpler—that it does not require such careful dimensioning of the tips—it does not call for the use of such high grade material. Against these advantages the necessity of heating the strips has to be considered although the number of men necessary for this process is less. On the whole, the speed of the welding machinery is necessarily not very high.—Machinery, March.

LEARNING THE TRADE, by David Baxter—An elementary discussion of the effects of expansion and contraction, and the necessity of making allowance for these forces in the welding shop.—Acetylene Journal, March.

ELECTRIC ARC WELDING APPARATUS AND EQUIPMENT, by J. Caldwell—Direct current multiple welder sets—their methods of control—their characteristic performance and method of tests—methods of regulating welding circuit. Alternating welding sets—various types of transformers for welding—types of electrodes which have been developed for the welding of copper, brass and bronze.—Acetylene & Welding Journal, London, February.

THE OXYGEN PETROL WELDING AND CUTTING PROCESS—The remarkable success of the oxy-acetylene welding process has led to attempts to find a substitute for acetylene. The oxygen petrol process has recently been introduced with claims of safety, economy, and efficiency in welding and cutting. The author endeavors to show that the oxy-petrol process is inferior in every respect to the oxy-acetylene process, because it is far more dangerous, it involves the risk of poisoning, it is more expensive, it does not make as good welds, and is not so convenient to use.—Acetylene & Welding Journal, London, February.

FUSION WELDING—GETTING RESULTS, by H. S. Card—The essentials of good welding by both oxy-acetylene and electric arc processes. The reasons for the most common failures in welding by both processes, and the methods of getting rid of such failures. Proper handling and care of welding equipment. The necessity for annealing. The importance of centralizing the welding department in the railroad shops.—Proceedings of the Car Foremen's Association of Chicago, February.

WELDING ON NEW ORLEANS RAILWAY, by E. J. Shulan—Description of an extensive program of track reclamation carried out by the New Orleans Railway & Light Co. One of the most important parts of this work was the welding of rail joints, and in the last fifteen months has made about 2,000 compromised joints in their own shops. Over 14,000 joints have been welded, and of this number only about 100 have failed. All welded joints are tested several months after welding with a storage battery current. Good results are also being secured in the welding of manganese crossings.—Electric Traction, March.

WELDING AND CUTTING BY THE CARBIC SYSTEM—A new catalogue of the Carbic Mfg. Co., Duluth, Minn. The catalogue is made up in sections, each section being devoted to either a description of apparatus, instructions for its use, or illustrations of application. The Carbic line includes the Carbic Acetylene Generator—Carbic Cakes—welding and cutting torches—regulators—trucks—welding rods and wire—fluxes and heating supplies. Several of the sections of this catalogue are printed in two colors, and the whole is conveniently arranged and practically printed. Special loose-leaf bulletins show the adaptability of the process to a great variety of repair work.

CHROME-NICKEL STEEL IN TRACK WORK, by F. G. Hibbard—The experience of Milwaukee Street Railroad with crossings made of cast chrome-nickel steel. Properties compared with manganese steel—welding and cutting qualities—heat treatment.—Iron Age, March 15th.

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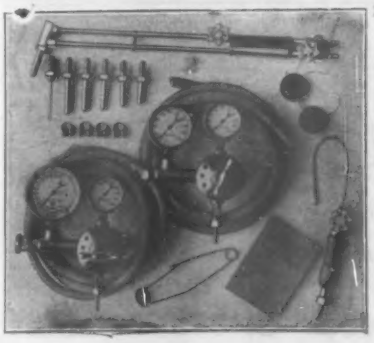

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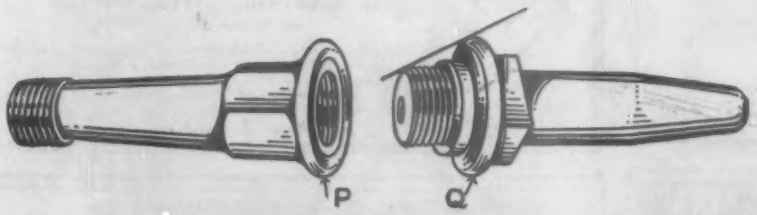

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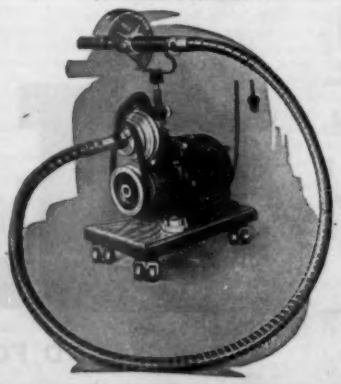

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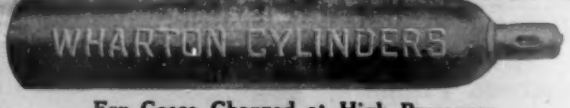

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